SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI

THREE YEAR UNDERGRADUATE PROGRAMME

B.Sc. PHYSICS

FACULTY: SCIENCE AND TECHNOLOGY

(Courses effective from Academic Year 2026-2027 Under Uniform NEP 2020)

Scheme of Teaching-Learning-Evaluation, Credit Distribution, Workload Calculation and Examination

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI
FACULTY: Science and Technology
Subject: PHYSICS
Teaching and Learning Scheme for the Degree of Bachelor of Science (B.Sc.)
Three Years / Four Years - (Six/Eight Semesters) Bachelor Degree Programme

FIRST YEAR: Level 4.5 - SEMESTER –I (T & L Credit Scheme)

Mode of Teaching	Vertical No	The Vertical	Type of Course	Course Code	Course Name	Credits	Workload (Hrs/Week)	Vertical Workload (Hrs/Week)
Classroom Teaching/ Lab Work (Practical/ Outdoor/ Field/Online /Hybrid)	A	Major	Physics MJ Theory – 1	129201	Gravitational and Rotational Dynamics	2	2	**6**
			Physics MJ Lab/ Practical – 1	129202	Experiments Related to Gravitational and Rotational Dynamics	2	4	
	B	Minor	Physics MN Theory – 1	129201	Gravitational and Rotational Dynamics	2	2	**6**
			Physics MN Lab/ Practical – 1	129202	Experiments Related to Gravitational and Rotational Dynamics	2	4	
	C	Generic Open Elective	Physics OE – 1	129203	Space Science (Wonders of Physics)	2	2	**4**
			Physics OE – 2	129204	Non-Conventional Energy Sources	2	2	
	D	VSC	-	-	-	-	-	**4**
		SEC	Physics SEC – 1 Lab/Practical	129205	Mathematical and Measurement Skills	2	4	
	E	AEC	-	-	-	*2*	2	***6***
		IKS	-	-	-	*2*	2	
		VEC	-	-	-	*2*	2	
	F	Int./App. /OJT	-	-	-	-	-	***4***
		FP/ CEP	-	-	-	-	-	
		CC	-	-	-	*2*	4	
TOTAL						**22**	**30**	**30**

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI

FACULTY: Science and Technology
Subject: PHYSICS
Teaching and Learning Scheme for the Degree of Bachelor of Science (B.Sc.)
Three Years / Four Years - (Six/Eight Semesters) Bachelor Degree Programme

FIRST YEAR: Level 4.5 - SEMESTER – II (T & L Credit Scheme)

Mode of Teaching	Vertical No	The Vertical	Type of Course	Course Code	Course Name	Credits	Workload (Hrs/Week)	Vertica Workload (Hrs/Week)
Classroom Teaching/ Lab Work (Practical/ Outdoor/ Field/Online /Hybrid)	A	Major	Physics MJ Theory – 2	129206	Oscillations and Properties of Matter	2	2	**6**
			Physics MJ Lab/ Practical – 2	129207	Experiments Related to Oscillations and Properties of Matter	2	4	
	B	Minor	Physics MN Theory – 2	129206	Oscillations and Properties of Matter	2	2	**6**
			Physics MN Lab/ Practical – 2	129207	Experiments Related to Oscillations and Properties of Matter	2	4	
	C	Generic Open Elective	Physics OE – 3	129208	Medical Physics	2	2	**4**
			Physics OE – 4	129209	Physics Behind Everyday Life	2	2	
	D	VSC	Physics VSC – 1 Lab/Practical	129210	Electric Technician-I	2	4	**8**
		SEC	Physics SEC – 2 Lab/Practical	129211	Mathematical and Instrumentation Skills	2	4	
	E	AEC	-	-	-	*2*	*2*	***4***
		IKS	-	-	-	-	-	
		VEC	-	-	-	*2*	*2*	
	F	Int./App. /OJT	-	-	-	-	-	***4***
		FP/ CEP	-	-	-	-	-	
		CC	-	-	-	*2*	*4*	
TOTAL						**22**	**32**	**32**

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI
FACULTY: Science and Technology Subject:
PHYSICS
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<u>SECOND YEAR</u>: <u>Level 5.0</u> - <u>SEMESTER – III</u> (T & L Credit Scheme)

Mode of Teaching	Vertical No	The Vertical	Type of Course	Course Code	Course Name	Credits	Workload (Hrs/Week)	Vertical Workload (Hrs/Week)
Classroom Teaching/ Lab Work (Practical/ Outdoor/ Field/Online/Hybrid)	A	Major Physics MJ	Physics MJ Theory 3	129212	Mathematical Physics, Electrostatics and Magnetostatics	2	2	**10**
			Physics MJ Theory 4	129213	Solid State Devices I	2	2	
			Physics MJ Lab/ Practical 3	129214	Experiments Related to MJ Th3 and MJ Th4	2	4	
		IKS- SS	IKS-Physics Theory	129215	IKS-Physics	2	2	
	B	Minor	Physics MN Theory 3	129216	Mathematical Physics and Solid-State Devices	2	2	**6**
			Physics MN Lab/ Practical 3	129217	Experiments Related to MN Th3	2	4	
	C	Generic/ Open Elective	Physics OE-5 Theory	129218	Solar Energy and Its Applications	2	2	**2**
	D	VSC	Physics VSC-2 Lab/ Practical	129219	Electrical Installation for Residential Buildings	2	4	**4**
		SEC				-	-	
	E	AEC				2	2	**2**
		IKS (Generic)				-	-	
		VEC				-	-	
	F	FP/CEP	Physics FP/CEP-1 Project	129220	Field Project / CE Services	2	4	**8**
		CC	Outdoor	-	Separate SOP will be released	*2*	*4*	
TOTAL						**22**	**32**	**32**

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SECOND YEAR: Level 5.0 - SEMESTER – IV (T & L Credit Scheme)

Mode of Teaching	Vertical No	The Vertical	Type of Course	Course Code	Course Name	Credits	Workload (Hrs/Week)	Vertical Workload (Hrs/Week)
Classroom Teaching/ Lab Work (Practical / Outdoor/ Field/Online/Hybrid)	A	Major	Physics MJ Theory 5	129221	Kinetic Theory of Gases and Thermodynamics	2	2	**10**
			Physics MJ Theory 6	129222	Solid State Devices-II	2	2	
			Physics MJ Theory 7	129223	Optics and Laser	2	2	
			Physics MJ Lab/Practical 4	129224	Experiments related to MJ Th5, Th6 and Th7	2	4	
	B	Minor	Physics MN Theory 4	129225	Transistor, Op-Amp, Fibre Optics and Laser	2	2	**6**
			Physics MN Lab/Practical 4	129226	Experiments related to MN Th4	2	4	
	C	Generic/ Open Elective	Physics OE-6 Theory	129227	Physics in Agriculture	2	2	**2**
	D	VSC	Physics VSC-3 Lab/Practical	129228	Mobile Repairing Technician	2	4	**4**
	E	AEC				2	2	***2***
		IKS (Generic)				-	-	
		VEC				-	-	
	F	FP/CES	Physics FP/CES-2 Project	129229	Field Project / CE Services	2	4	**8**
		CC	Outdoor	-	Separate SOP will be released	2	4	
TOTAL						**22**	**32**	**32**

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI
FACULTY: Science and Technology Subject:
PHYSICS
Teaching and Learning Scheme for the Degree of Bachelor of Science (B.Sc.)
Three Years / Four Years - (Six/Eight Semesters) Bachelor Degree Programme

THIRD YEAR: Level 5.5 - SEMESTER – V (T & L Credit Scheme)

Mode of Teaching	Vertical No	The Vertical	Type of Course	Course Code	Course Name	Credits	Workload (Hrs/Week)	Vertical Workload (Hrs/Week)
Classroom Teaching/ Lab Work (Practical/ Outdoor/ Field/Online/Hybrid)	A	Major	Physics MJ Theory 8	129230	Atomic and Molecular Physics	2	2	**10**
			Physics MJ Theory 9	129231	Network Theorems and Statistical Mechanics	2	2	
			Physics MJ Theory 10	129232	Solid State Physics I	2	2	
			Physics MJ Lab/Practical 5	129233	Experiments related to MJ Th8, Th9 and Th10	2	4	
		Elective 1(a) or 1(b)	Physics EL Theory 1(a)	129234	Digital Electronics - I	2	2	**6**
			Physics EL Theory 1(b)	129235	Python Programming - I	2	2	
			Physics EL Lab/Practical 1(a)	129236	Experiments related to Digital Electronics - I	2	4	
			Physics EL Lab/Practical 1(b)	129237	Experiments related to Python Programming - I	2	4	
	B	Minor	Physics MN Theory 5	129238	Solid State Physics and Network Theorems	2	2	**6**
			Physics MN Lab/Practical 5	129239	Experiments related to MN Th5	2	4	
	C	Generic/ Open Elective				0	0	**0**
	D	VSC	Physics VSC-4 Lab/Practical	129240	Maintenance and Repairing of Domestic Appliances	2	4	**8**
		SEC	Physics SEC-3 Lab/Practical	129241	Fundamentals of Computer Applications in Physics Laboratory and Scilab Programming	2	4	
	E	AEC				-	-	**0**
		IKS (Generic)				-	-	
		VEC				-	-	
	F	Internship/ Apprenticeship/ OJT				0	0	**4**
		FP/CES	Physics FP/CES-2 Project	129242	Field Project / CE Services	2	4	
		CC				0	0	
Total						**22**	**34**	**34**

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI

FACULTY: Science and Technology Subject:

PHYSICS

Teaching and Learning Scheme for the Degree of Bachelor of Science (B.Sc.)

Three Years / Four Years - (Six/Eight Semesters) Bachelor Degree Programme

THIRD YEAR: Level 5.5 - SEMESTER – VI (T & L Credit Scheme)

Mode of Teaching	Vertical No	The Vertical	Type of Course	Course Code	Course Name	Credits	Workload (Hrs/Week)	Vertical Workload (Hrs/Week)
Classroom Teaching/ Lab Work (Practical/ Outdoor/ Field/Online/Hybrid)	A	Major	Physics MJ Theory 11	129243	Nuclear and Particle Physics	2	2	**10**
			Physics MJ Theory 12	129244	Quantum Mechanics	2	2	
			Physics MJ Theory 13	129245	Solid State Physics II	2	2	
			Physics MJ Lab/Practical 6	129246	Experiments related to MJ Th11, Th12 and Th13	2	4	
		Elective 2(a) or 2(b)	Physics EL Theory 2(a)	129247	Digital Electronics- II	2	2	**6**
			Physics EL Theory 2(b)	129248	Python Programming- II	2	2	
			Physics EL Lab/Practical 2(a)	129249	Experiments related to Digital Electronics- II	2	4	
			Physics EL Lab/Practical 2(b)	129250	Experiments related to Python Programming- II	2	4	
	B	Minor	Physics MN Theory 6	129251	Quantum Mechanics and Solid State Physics	2	2	**6**
			Physics MN Lab/Practical 6	129252	Experiments related to MN Th6	2	4	
	C	Generic/ Open Elective				0	0	**0**
	D	VSC	Physics VSC-5 Lab/Practical	129253	Solar Energy Technology and Applications	2	4	**4**
		SEC				0	0	
	E	AEC				-	-	**0**
		IKS (Generic)				-	-	
		VEC				-	-	
	F	Internship/ Apprenticeship/ OJT	Physics Int/App/OJT	129254	Internship/ Apprenticeship/ On-the-Job Training (OJT) in the Physics domain	4	8	**8**
		FP/CES				0	0	
		CC				0	0	
TOTAL						**22**	**34**	**34**

Important:

- **VSC Should be Complementary to Major**
- **SEC must be selected from the Basket Provided by University, from the same Faculty/Discipline of the Major/Minor**
- As per Sant Gadge Baba Amravati University, Amravati Extra-Ordinary Notification No. No. 241/2025 Dated 24/12/2025 "Foundation of Artificial Intelligence" is the Mandatory **Non Credit Course** compulsory course for all the UG students in fifth semester of all undergraduate programs of all faculties in Sant Gadge Baba Amravati University, Amravati to earn their degree
- Students must select **Any One** of the Major-Elective Courses with respective Practical Course in Semester V and **same shall be continued** for Semester VI

SWAYAM/NPTEL Courses under NEP 2020

Sr. No.	Name of Course	Semester	Course Coordinator	Course Duration	Course Credit	Date of Course Commencement	Link
01	Newtonian Mechanics with Examples	I	Prof. Shiladitya Sengupta, IIT Roorkee	8 Weeks	3 Credit	Jul 27, 2026	https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_ph41
02	Concepts in Magnetism and Superconductivity	V	Prof. A Taraphder, IIT Kharagpur	8 Weeks	3 Credit	Jul 27, 2026	https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_ph42
03	Introduction to Electromagnetic Theory (Hindi)	III	Prof. Manoj Harbola, IIT Kanpur	12 Weeks	4 Credit	Jul 27, 2026	https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_ph55
04	Essentials of Quantum Optics	II	Prof. Amarendra Kumar Sarma, IIT Guwahati	8 Weeks	3 Credit	Aug 17, 2026	https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_ph66
05	Solar Photovoltaic System Design	IV	Prof. Rhythm Singh, IIT Roorkee	8 Weeks	3 Credit	Aug 17, 2026	https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_ph65
06	Solar Photovoltaics Fundamentals, Technology and Applications	VI	Prof. Soumitra Satapathi, IIT Roorkee	8 Weeks	3 Credit	Jul 27, 2026	https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_ph40

Instructions for Enrollment in SWAYAM/NPTEL Courses under NEP 2020

All students of **B.Sc. with Physics as Major or Minor** of all semesters are encouraged to enroll in suitable SWAYAM/NPTEL online courses to enhance their academic knowledge, practical skills, and employability.

General Instructions

1. Students may choose any course of their interest listed in table above for specific semester.
2. Before enrollment, students must ensure that they have an active Academic Bank of Credits (ABC) ID. The same ABC ID should be used while registering for the selected SWAYAM/NPTEL course so that earned credits can be deposited in the Academic Bank of Credits.
3. Students should carefully read the course details including duration, eligibility, syllabus, examination schedule, and credit structure before enrolling.
4. Merely enrolling in a course does not make a student eligible for academic credits. Students must:
   Complete the course requirements, Appear for the proctored examination, and Successfully pass the examination as per the norms prescribed by SWAYAM/NPTEL.
5. Credits will be awarded only after successful completion and certification of the course by the concerned agency.
6. Every student must submit the details of the enrolled course to the Department of Botany immediately after registration.
7. Submission of enrollment details to the Department is mandatory to facilitate record maintenance and compliance with University requirements regarding credit transfer and academic documentation.
8. Students are advised to preserve all course-related documents, including Enrollment confirmation, Course progress records, Examination registration receipt, Score card, Final certificate.
9. Students shall be responsible for timely registration for the examination, payment of examination fees (if applicable), and completion of all course requirements within the stipulated period.
10. The Department of shall not be responsible for missed deadlines, incomplete registrations, examination non-appearance, or failure to satisfy the certification requirements of the concerned SWAYAM/NPTEL course.
11. After successful completion of the course, students must submit a copy of the course certificate and score card to the Department of Botany for further processing and reporting to the University.

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FACULTY: Science and Technology
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Three Years / Four Years - (Six/Eight Semesters) Bachelor Degree Programme

Examination, Evaluation and Assessment Scheme

Vertical No.	The Vertical	Mode of Examination, Evaluation & Assessment	Theory					Theory (Total)		Practical					Practical (Total)	
			External			Internal				External			Internal			
			Max. Marks	Min. Marks	Duration (Hrs.)	Max. Marks	Min. Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks	Duration (Hrs.)	Max. Marks	Min. Marks	Max. Marks	Min. Marks
A	**Major**	External & Internal	**30**	**9**	**2**	**20**	**6**	**50**	**20**	**25**	**10**	**3**	**25**	**10**	**50**	**20**
	IKS Major Specific		**30**	**9**	**2**	**20**	**6**	**50**	**20**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
B	**Minor**		**30**	**9**	**2**	**20**	**6**	**50**	**20**	**25**	**10**	**3**	**25**	**10**	**50**	**20**
C	**Generic/ Open Elective**	**Internal**	**-**	**-**	**-**	**50**	**20**	**50**	**20**	**--**	**--**	**-**	**--**	**--**	**--**	**--**
D	**VSC**	**Internal**	**--**	**--**	**-**	**-**	**-**	**-**	**-**	**--**	**--**	**-**	**50**	**20**	**50**	**20**
	SEC	**Internal**	**--**	**--**	**-**	**-**	**-**	**-**	**-**	**--**	**--**	**-**	**50**	**20**	**50**	**20**
F	**Internship/ Apprenticeship**	**Internal**	Assessment of these verticals shall be based on various activities/practices. It shall be evaluated by giving maximum marks of 50 per 2 Credit Course with separate activity weightages/levels. A detailed SOP for this assessment process shall be prescribed separately.													
	FP/CEP															
	CC															

Internal Assessment for Theory/Practical/Laboratory:

All the internal assessments should be conducted on the basis of Continuous Assessment Tests (CAT).

Continuous Assessment Tests (CAT):

For internal assessment, the Continuous Assessment Tests (CAT) shall be conducted as under

i. Three CAT each of 10 Marks (Theory) and 10 Marks (Practical).
   - First on completion of 25% Syllabus of the course or on completion of 25 teaching days,
   - Second on completion of 50% Syllabus of the course or on completion of 50 teaching days,
   - Third on completion of 75% Syllabus of the course or on completion of 75 teaching days.

ii. Each concurrent assessment (CAT-I, II & III) will be mapped to relevant Course Learning Outcome.

iii. Total Performance in CAT (i.e.40 %) shall be based on the best two out of three in CAT examinations

iv. Internal assessment shall be carried out by the respective course teacher by choosing variety of assessment tools/methods such as class test, seminar, case study, field work, mini project work, quiz or any innovative method, which may be deemed to be appropriate for assessing the relevant course outcome.

External Assessment for Practical (Major/Minor Lab):

- Experiment Performance : 20 Marks
- Viva-Voce : 05 Marks
- Total : 25 Marks

- Duration of Examination : 03 Hrs.

Internal Assessment for Practical (Major/Minor Lab):

- Internal Assessment based on CAT : 20 Marks
- Record Book : 05 Marks
- Total : 25 Marks

Internal Assessment for OE:

- Internal Assessment based on CAT : 20 Marks
- End Semester Examination : 30 Marks
- Total : 50 Marks
- Duration of End Semester Examination : 02 Hrs.

Internal Assessment for Practical (SEC/VSC Lab):

- Internal Assessment based on CAT : 20 Marks
- Record Book : 10 Marks
- End Semester Examination : 20 Marks
  (Experiment/ Demonstration/ Hands on Activity Performance: 15 Marks + Viva-Voce: 05 Marks)
- Total : 50 Marks
- Duration of End Semester Examination : 03 Hrs.

Note: The external assessments of theory courses will be conducted in accordance with the guidelines issued by the SGBA University.

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI

Three/Four Years – Six/Eight Semesters Bachelor’s Degree Programme
3 Years B.Sc. / 4 Years B.Sc. (Hons.) & 4 Years B.Sc. (Hons. with Research) Programme

Faculty of
Science and Technology
(Science Group)

Subject: **PHYSICS**
(Semesters I and II)

Effective from Academic Year 2026-27
(As per NEP 2020)

Contents

Graduation Attributes

Graduation attributes for a Bachelor of Science (B.Sc.) with Physics as a major course represent the qualities, skills, and abilities that students are expected to develop by the end of the program. These attributes ensure that graduates are well-prepared for their future careers and further studies. Here are some key graduation attributes for B.Sc. Physics graduates:

1. Deep understanding of fundamental physics concepts and principles.
2. Ability to analyze complex problems logically and critically.
3. Expertise in designing and conducting experiments, as well as in using modern laboratory equipment.
4. Proficiency in conducting independent research, including literature review, hypothesis development, experimentation, and data analysis.
5. Strong problem-solving skills, with the ability to approach and resolve complex scientific and technical issues.
6. Effective communication skills, both written and oral, for conveying scientific information to diverse audiences.
7. Understanding of ethical principles in scientific research and professional practice.
8. Ability to work effectively in teams, contributing to collaborative projects and interdisciplinary research.
9. Commitment to continuous learning and staying updated with advancements in physics and related fields.
10. Competence in using computational tools, software, and programming languages relevant to physics.
11. Understanding of global challenges and the role of physics in addressing issues such as climate change, energy sustainability, and environmental conservation.
12. Preparedness for a wide range of career opportunities in academia, industry, government, and other sectors.

These graduation attributes collectively ensure that B.Sc. Physics graduates are not only knowledgeable and skilled in their field but also well-rounded individuals ready to contribute positively to society and their chosen professions.

Programme Outcomes

On successful completion of this programme, the student will be able to:

1. Understand physics fundamental concepts, including mechanics, electromagnetism, thermodynamics, quantum mechanics, and statistical physics.
2. Analyze and solve complex physical problems using mathematical and computational techniques.
3. Experience in conducting independent research projects, including literature review, hypothesis formulation, experimentation, data collection, and analysis.
4. Communicate complex scientific concepts clearly and effectively to diverse audiences, including peers, professionals, and the general public.
5. Understand global scientific challenges and the role of physics in addressing environmental and sustainability issues.
6. Acquire vocational and technical skills related to allied areas of physics and their practical applications.
7. To acquaint students with the cross-cutting and interdisciplinary areas related to physics and its applications.
8. Apply physics knowledge to develop sustainable solutions and innovations.

Programme Specific Outcomes

- PSO1: Graduates will acquire a comprehensive knowledge and sound understanding of fundamentals of Physics.
- PSO2: Graduates will develop practical, analytical and mathematical skills in Physics.
- PSO3: Graduates will acquire technical and vocational skills in physics and allied areas for self-employment and entrepreneurship opportunities.
- PSO4: Graduates will be prepared to acquire a range of general skills, to solve problems, to evaluate information, to use computers productively, to communicate with society effectively and learn independently.
- PSO5: Graduates will acquire necessary skills to enable them to crack competitive examination for career progression or seeking employment.

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A	**Major**	**External &Internal**	**30**	**9**	**2**	**20**	**6**	**50**	**20**	**25**	**10**	**3**	**25**	**10**	**50**	**20**
B	**Minor**		**30**	**9**	**2**	**20**	**6**	**50**	**20**	**25**	**10**	**3**	**25**	**10**	**50**	**20**
C	**Generic/ Open Elective**	**Internal**	-	-	-	**50**	**20**	**50**	**20**	--	--	-	--	--	--	--
D	**VSC**	**Internal**	--	--	-	-	-	-	-	--	--	-	**50**	**20**	**50**	**20**
	SEC	**Internal**	--	--	-	-	-	-	-	--	--	-	**50**	**20**	**50**	**20**
E	**AEC (Eng. & One MIL Composite)**		-	-	-	-	-	-	-	-	-	-	-	-	-	-
	IKS (Generic)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	VEC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	**Internship/ Apprenticeship**	**Internal**	Assessment of these verticals shall be based on various activities/practices. It shall be evaluated by giving maximum marks of 50 per 2 Credit Course with separate activity weightages/levels. A detailed SOP for thisassessment process shall be prescribed separately.													
	FP/CEP															
	CC															

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iii. Total Performance in CAT (i.e.40 %) shall be based on the best two out of three in CAT examinations

iv. Internal assessment shall be carried out by the respective course teacher by choosing variety of assessment tools/methods such as class test, seminar, case study, field work, mini project work, quiz or any innovative method, which may be deemed to be appropriate for assessing the relevant course outcome.

External Assessment for Practical (Major/Minor Lab):

- Experiment Performance : 20 Marks
- Viva-Voce : 05 Marks
- **Total : 25 Marks**
- Duration of Examination : 03 Hrs.

Internal Assessment for Practical (Major/Minor Lab):

- Internal Assessment based on CAT : 20 Marks
- Record Book : 05 Marks
- **Total : 25 Marks**

Internal Assessment for OE:

- Internal Assessment based on CAT : 20 Marks
- End Semester Examination : 30 Marks
- **Total : 50 Marks**
- Duration of End Semester Examination : 02 Hrs.

Internal Assessment for Practical (SEC/VSC Lab):

- Internal Assessment based on CAT : 20 Marks
- Record Book : 10 Marks
- End Semester Examination : 20 Marks
  (Experiment/ Demonstration/ Hands on Activity Performance: 15 Marks + Viva-Voce: 05 Marks)
- **Total : 50 Marks**
- Duration of End Semester Examination : 03 Hrs.

Note: The external assessments of theory courses will be conducted in accordance with the guidelines issued by the SGBA University.

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Teaching and Learning Scheme for the Degree of Bachelor of Science (B.Sc.)
Three Years / Four Years - (Six/Eight Semesters) Bachelor Degree Programme

FIRST YEAR: Level 4.5 - SEMESTER –I (T & L Credit Scheme)

Mode of Teaching	Vertical No	The Vertical	Type of Course	Course Code	Course Name	Credits	Workload (Hrs/Week)	Vertical Workload (Hrs/Week)
Classroom Teaching/ Lab Work (Practical/ Outdoor/ Field/Online /Hybrid)	A	Major	Physics MJ Theory – 1	129201	Gravitational and Rotational Dynamics	2	2	**6**
			Physics MJ Lab/ Practical – 1	129202	Experiments Related to Gravitational and Rotational Dynamics	2	4	
	B	Minor	Physics MN Theory – 1	129201	Gravitational and Rotational Dynamics	2	2	**6**
			Physics MN Lab/ Practical – 1	129202	Experiments Related to Gravitational and Rotational Dynamics	2	4	
	C	Generic Open Elective	Physics OE – 1	129203	Space Science (Wonders of Physics)	2	2	**4**
			Physics OE – 2	129204	Non-Conventional Energy Sources	2	2	
	D	VSC	-	-	-	-	-	**4**
		SEC	Physics SEC – 1 Lab/Practical	129205	Mathematical and Measurement Skills	2	4	
	E	AEC	-	-	-	*2*	2	***6***
		IKS	-	-	-	*2*	2	
		VEC	-	-	-	*2*	2	
	F	Int./App. /OJT	-	-	-	-	-	***4***
		FP/ CEP	-	-	-	-	-	
		CC	-	-	-	*2*	4	
TOTAL						**22**	**30**	**30**

<table>
<tr><th colspan="2">Physics MJ/MN Theory 1 – 129201</th></tr>
<tr><th colspan="2">Gravitation and Rotational Dynamics</th></tr>
<tr><th>Credits: 02</th><th>Workload (Hrs./Week): 02</th></tr>
<tr><td>Course Objectives:</td><td>1. To explain the concept of gravitational force and its universal nature.
2. To understand the laws of gravitation proposed by Newton and explore their implications.
3. To solve problems related to gravitational attraction between masses.
4. To investigate the effect of gravity on motion and orbits, including satellite motion.
5. To introduce the principles of rotational motion and dynamics.
6. To explore the concept of torque and its relationship with rotational motion.
7. To understand the parallel axis and perpendicular axis theorems.
8. To solve problems involving rotational motion, torque, and angular acceleration.</td></tr>
<tr><td>Course Outcomes:</td><td>By the end of the course, students will be able to:
1. Interpret the universal law of gravitation, gravitation field and gravitation potential.
2. Apply Kepler's laws to describe the motion of planets and other celestial bodies.
3. Understand the motion of satellites in orbit
4. Know the concept of Black-hole.
5. Relate rotational motion to linear motion through angular and linear quantities.
6. Discuss the basic concepts of rotational dynamics and relate it with appropriate things.
7. Apply the parallel axes theorem and perpendicular axes theorem to calculate moments of inertia.
8. Discuss real world applications of rotational mechanics, such as the dynamics of rotating machinery and vehicles.</td></tr>
</table>

Unit	Contents	Work-load Allotted	Weight-age of Marks Allotted	Incorporation of Pedagogies
I	**Gravitation I:** Historical perspective, Universal law of Gravitation, Measurement of Gravitational constant, Gravitational potential energy, Gravitational potential, Gravitational Field, Relation between Gravitational Field and Potential. Calculation of Gravitational Potential and Field due to point mass, uniform ring, Uniform thin spherical shell and Uniform solid sphere, Numerical.	8 Hrs	8 Marks	• Use diagrams, simulations, or animations to illustrate gravitational concepts, potential, and field lines. • Provide step-by-step calculations for gravitational potential and field for different configurations to reinforce understanding. • Engage students with interactive simulations or experiments showcasing gravitational effects and field variations.
II	**Gravitation II:** Acceleration due to gravity, Effect of altitude and depth in the value of 'g', Kepler's laws (statement only), Projection of Satellite, Critical velocity of a satellite, Periodic time of satellite, Binding energy and escape velocity of a satellite. Weightlessness condition in satellite. Concept of Black-hole. Numerical.	7 Hrs	8 Marks	• Use diagrams, animations, or simulations to illustrate orbital mechanics, satellite motion, and the concept of black holes. • Relate these concepts to real-life scenarios, such as satellite launches, space missions, and astronomical observations. Engage students in discussions about the implications of gravity variations, satellite motion, and the fascinating nature of black holes in the universe.
III	**Rotational Dynamics-I:** Rigid body, Torque on a rigid body, Centre of mass, System of two particles, Equation of motion of centre of mass. Rotation about fixed axis, Kinetic energy of rotating body, Moment of Inertia, Physical significance of moment of inertia, Radius of gyration, Analogy between translatory and rotatory motion, Angular Momentum,	8 Hrs	8 Marks	• Use animations, diagrams, or physical models to illustrate concepts like center of mass, moment of inertia, and rotational motion. • Engage students in solving problems related to torque, moment of inertia, and conservation of angular momentum to reinforce concepts.

	Law of conservation of angular momentum, Numerical.			• Conduct experiments or demonstrations to illustrate rotational motion.
IV	**Rotational Dynamics-II:** Theorem of perpendicular axes, Theorem of parallel axes, Calculation Moment of inertia (Annular ring, Circular disc, Solid cylinder, thin rod, Hollow cylinder, Solid sphere & Spherical shell.) Kinetic energy of a body rolling on a horizontal plane, Numerical.	7 Hrs	8 Marks	• Present step-by-step derivations of moment of inertia equations for various shapes and objects. • Engage students in solving problems involving moments of inertia and kinetic energy of rolling bodies to reinforce understanding. • Use diagrams, animations, or physical demonstrations to illustrate the concepts of moments of inertia and rolling motion.

References:	1. *An Introduction to Mechanics* by Daniel Kleppner and Robert J. Kolenkow, McGraw-Hill Education, New Delhi. 2. *Mechanics* by Charles Kittel, Walter D. Knight et al., Tata McGraw-Hill Publishing Company, New Delhi. 3. *Physics* by David Halliday, Robert Resnick, and Jearl Walker, Wiley India Pvt. Ltd., New Delhi. 4. *Analytical Mechanics* by G. R. Fowles and G. L. Cassiday, Cengage Learning India Pvt. Ltd., New Delhi, 2005. 5. *The Feynman Lectures on Physics, Vol. I* by Richard P. Feynman, Robert B. Leighton, and Matthew Sands, Pearson Education, New Delhi, 2008. 6. *Mechanics* by D. S. Mathur, S. Chand & Company Pvt. Ltd., New Delhi. 7. *Physics for Degree Students: B.Sc. First Year* by C. L. Arora and P. S. Hemne, S. Chand Publications, New Delhi. 8. *Concepts of Physics, Vol. I* by H. C. Verma, Bharati Bhawan Publishers, Patna. 9. *Classical Mechanics* by J. C. Upadhyaya, Himalaya Publishing House, Mumbai. 10. *University Physics* by Ronald Lane Reese, Thomson Brooks/Cole Publications.

Model questions for theory external/ internal examination.	
Very Short Answer Questions (1 Mark)	1. Define gravitational potential. 2. State Newton's universal law of gravitation. 3. Define escape velocity. 4. What is the SI unit of torque? 5. Define radius of gyration.
Short Answer Questions (3 Marks)	1. Explain the relation between gravitational field and gravitational potential. 2. Discuss the effect of altitude on acceleration due to gravity. 3. Define moment of inertia and explain its physical significance. 4. Differentiate between translational and rotational motion. 5. Explain the concept of weightlessness in satellites.
Long Answer Questions (6 Marks)	1. Derive an expression for variation of acceleration due to gravity with altitude. 2. State and prove the theorem of parallel axes. 3. Derive the relation between gravitational field intensity and gravitational potential. 4. Obtain an expression for kinetic energy of a rotating body. 5. Explain Kepler's laws and their significance in planetary motion.

<table>
<tr><th colspan="2">Physics MJ/MN Lab/ Practical 1 – 129202</th></tr>
<tr><th colspan="2">Experiments related to Gravitation and Rotational Dynamics</th></tr>
<tr><th>Credits: 02</th><th>Workload (Hrs./Week): 04</th></tr>
<tr><td>Course Objectives:</td><td>1. To develop understanding of oscillatory motion, pendulum dynamics, and rotational mechanics through experimental methods.
2. To impart practical knowledge of determining acceleration due to gravity using different pendulum and free-fall techniques.
3. To familiarize students with the concepts of moment of inertia and verification of theorems related to rotational motion.
4. To develop experimental skills in handling laboratory apparatus, taking precise measurements, and analyzing observational data.
5. To enhance scientific aptitude, analytical thinking, and problem-solving abilities through mechanics-based laboratory experiments.</td></tr>
<tr><td>Course Outcomes:</td><td>By the end of this course, students will be able to:
1. Determine acceleration due to gravity using various experimental methods such as simple pendulum, bar pendulum, Kater’s pendulum, and free-fall method.
2. Determine the moment of inertia of different bodies using torsion pendulum, bifilar suspension, flywheel, and compound pendulum methods.
3. Verify the theorems of parallel and perpendicular axes related to moment of inertia.
4. Analyze oscillatory motion, damping effects, and equivalent pendulum concepts using experimental observations.
5. Demonstrate skills in precision measurement, data analysis, error estimation, graphical representation, and scientific reporting in mechanics experiments.</td></tr>
</table>

List of Experiments:
Perform at least eight (8) experiments from the given list.
1. To determine acceleration due to gravity by simple pendulum. 2. To determine acceleration due to gravity by Bar pendulum. 3. To determine acceleration due to gravity by Kater's reversible pendulum. 4. To determine acceleration due to gravity by free fall method. 5. To determine Moment of Inertia of a body by a torsion pendulum. 6. To study the theorem of parallel axes of Moment of Inertia 7. To study the theorem of perpendicular axes of Moment of Inertia 8. To determine the Moment of Inertia of a body using bifilar suspension method (with parallel strings/threads) 9. To determine Moment of inertia of a fly-wheel. 10. To determine the length of equivalent pendulum (ring pendulum). 11. To determine the length of equivalent pendulum (disc pendulum). 12. To determine moment of inertia of a compound pendulum by method of coincidences 13. To study damping of a bar pendulum (logarithmic decrement).

References:	1. *B.Sc. Practical Physics* by Harnam Singh and P. S. Hemne, S. Chand & Company Pvt. Ltd., New Delhi. 2. *Textbook of Practical Physics* by H. P. Shrivastava, ABD Publishers, Jaipur. 3. *B.Sc. Practical Physics* by C. L. Arora, S. Chand & Company Pvt. Ltd., New Delhi. 4. *Practical Physics* by S. L. Gupta and V. Kumar, Pragati Prakashan, Meerut. 5. *University Practical Physics* by D. C. Tayal, Himalaya Publishing House, Mumbai. 6. *Advanced Practical Physics for Students* by B. L. Flint and H. T. Worsnop, Asia Publishing House, New Delhi. 7. *A Textbook of Practical Physics* by Indu Prakash and Ramakrishna, Kitab Mahal Publishers, Allahabad. 8. Amrita Virtual Labs – https://vlab.amrita.edu/ 9. Virtual Labs India – https://www.vlab.co.in/ 10. IIT Bombay Virtual Labs – https://vlabs.iitb.ac.in/vlab/labsps.ht

Physics OE-1 Theory – 129203	
Space Science (Wonders of Physics)	
Credits: 02	**Workload (Hrs./Week): 02**
Course Objectives:	1. To introduce the fundamental concepts of space science, origin of the solar system, and structure of the universe. 2. To understand the physical characteristics and motions of the Sun, planets, satellites, asteroids, and comets. 3. To study Kepler's laws and Newton's law of gravitation and their applications in celestial mechanics. 4. To understand stellar spectra, classification of stars, and different stages of stellar evolution. 5. To develop knowledge about galaxies, their evolution, and the early history and origin of the universe.
Course Outcomes:	1. Explain the origin and evolution of the solar system and the role of nuclear reactions in solar energy generation. 2. Describe the properties and motions of planets, satellites, asteroids, and comets in the solar system. 3. Apply Kepler's laws and Newton's law of gravitation to understand planetary motion and determination of planetary masses. 4. Classify stars based on their spectra and luminosity and explain stellar evolution including white dwarfs, neutron stars, and black holes. 5. Discuss the origin, structure, and evolution of galaxies and explain the early history of the universe.

Unit	Contents	Work load Allotted	Weight-age of Marks Allotted	Incorporation of Pedagogies
I	Introduction to space science, Nebular theory of formation of our Solar System. Solar wind and nuclear reaction as the source of energy. Sun and Planets: Brief description about shape size, period of rotation about axis and period of revolution, distance of planets from sun. Kepler's Laws of planetary motion (only Statements).	7 Hrs	8 Marks	• Use images, videos, or models to illustrate the solar system's formation, planetary characteristics, and Kepler's laws. • Encourage comparisons between planets regarding size, distance from the sun, and orbital characteristics to foster a deeper understanding. • Engage students with quizzes, discussions, or simulations related to solar system formation and planetary motion laws.
II	Newton's Law of gravitation, determination of mass of earth, determination of mass of planets with respect to earth. Brief description of Asteroids, Satellites and Comets.	8 Hrs	8 Marks	• Use images, diagrams, or animations to illustrate Newton's law of gravitation, experimental setups, and characteristics of celestial bodies. • Compare the masses and characteristics of Earth with other planets, asteroids, and comets to demonstrate their diversity. • Engage students in exercises or problems related to gravitational calculations and characteristics of celestial bodies to reinforce understanding.
III	Stellar spectra and structure, Classification of stars: Luminosity of star, variable stars; composite stars (white dwarfs, Neutron stars, black hole, star clusters, supernova and binary stars).	7 Hrs	8 Marks	• Use interactive simulations or software to illustrate stellar spectra, star classifications, and variable star behavior. • Compare the characteristics, formation, and life cycles of different types of stars and stellar phenomena.

				• Utilize images, animations, or videos to showcase the diverse nature of stars, clusters, and supernovae.
IV	Galaxies and their evolution and origin, Early history of the universe.	8 Hrs	8 Marks	• Use visual aids such as images, diagrams, or animations illustrating galaxy types, cosmic evolution, and the early universe's timeline. • Compare different galactic structures, their evolution pathways, and theoretical models explaining the universe's origins. • Encourage discussions on cosmic evolution theories, observational evidence, and ongoing research to engage students in critical thinking and exploration.

References	1. *Introduction to Space Sciences and Spacecraft Applications* by Bruce A. Campbell and Samuel Walter McCandless Jr., Gulf Publishing Company, Houston, 1996. 2. *Wonders of the Solar System* by Brian Cox and Andrew Cohen, Harper Collins Publishers, 2010. 3. *The Classification of Stars* by Carlos Jaschek and Mercedes Jaschek, Cambridge University Press, 1990. 4. *The Origin and Evolution of Galaxies* by Venzo de Sabbata, World Scientific Publishing Co. Pvt. Ltd., 1982. 5. *Understanding Space: An Introduction to Astronautics* by Jerry Sellers, McGraw-Hill Education, 3rd Edition. 6. *On Civilized Stars* by Joseph F. Baugher, Prentice Hall Publications, 1985. 7. *Galaxies in the Universe: An Introduction* by Linda S. Sparke and John S. Gallagher III, Cambridge University Press, 2010. 8. *The Accidental Universe* by P. C. W. Davies, Cambridge University Press, Cambridge, 1982. 9. *Astronomy: Principles and Practice* by A. E. Roy and D. Clarke, Institute of Physics Publishing, Bristol. 10. *Study of Whole Universe* by D. S. Janorkar, Om Publications, Mahan, Akola, 2024. 11. *Astronomy and Space Theory* by D. S. Janorkar, Om Publications, Mahan, Akola, 2024.

Model questions for theory external/ internal examination.	
Very Short Answer Questions (1 Mark)	1. State Kepler's first law. 2. Define solar wind. 3. What is a black hole? 4. Define asteroid. 5. What is a galaxy?
Short Answer Questions (3 Marks)	1. Explain the nebular theory of the origin of the solar system. 2. Differentiate between asteroids and comets. 3. Explain luminosity of stars. 4. Describe binary stars. 5. Explain Newton's law of gravitation.
Long Answer Questions (6 Marks)	1. Explain the structure and evolution of galaxies. 2. Describe the classification of stars with suitable examples. 3. Explain Kepler's laws of planetary motion. 4. Discuss the origin and evolution of the universe. 5. Explain the determination of mass of the Earth using Newton's law of gravitation.

Physics OE-2 Theory – 129204	
Non-Conventional Energy Sources	
Credits: 02	**Workload (Hrs./Week): 02**
Course Objectives:	1. To introduce the need and importance of non-conventional and renewable energy sources in modern society. 2. To understand the principles, construction, and working of fuel cells and their applications. 3. To study the utilization of solar energy through different solar energy collection and conversion systems. 4. To understand the working principles, components, and applications of wind energy conversion systems. 5. To develop knowledge about ocean energy and geothermal energy resources, their methods of energy conversion, advantages, limitations, and applications.
Course Outcomes:	1. Explain the necessity and different types of non-conventional energy sources for sustainable energy development. 2. Describe the design, working principle, advantages, disadvantages, and applications of fuel cells. 3. Analyze solar energy systems including solar collectors and solar ponds for energy conversion applications. 4. Explain the operation and performance of wind energy conversion systems with horizontal and vertical axis rotors. 5. Discuss the principles and applications of ocean thermal energy conversion, tidal energy, and geothermal energy systems.

Unit	Contents	Workload Allotted	Weight-age of Marks Allotted	Incorporation of Pedagogies
I	**Non-conventional Energy Sources:** Need for non-conventional energy sources, Types of Non- Conventional energy sources Fuel cells: Definition-Design and Principle of operation Advantages and Disadvantages of fuel cells-Applications of Fuel cells.	8 Hrs	8 Marks	• Present real-world examples showcasing the implementation and success of fuel cell technology. • Engage students with interactive models or simulations illustrating fuel cell operations. • Encourage debates on the feasibility and challenges of adopting fuel cells as a viable energy solution.
II	**Solar Energy:** Solar radiation and its measurements-Solar energy collectors: Flat Plate and Concentrating Collectors- solar pond -Applications of Solar energy.	7 Hrs	8 Marks	• Conduct experiments or demonstrations showcasing solar radiation measurement techniques and the operation of solar collectors. • Organize visits to solar installations or facilities utilizing solar energy to provide practical insights. • Assign projects where students design and analyze solar energy systems for specific applications.
III	**Wind Energy:** Nature of wind-Basic components of Wind Energy Conversion System (WECS)- Wind energy collectors: Horizontal and vertical axis rotors- Advantages and Disadvantages of WECS - Applications of wind energy.	7 Hrs	8 Marks	• Utilize simulations or models to demonstrate the functioning of wind turbines and their efficiency. • Organize visits to wind farms or facilities utilizing wind energy to observe real-world applications. • Foster discussions on the societal impact, environmental considerations, and technological advancements in wind energy.
IV	**Ocean Energy:** Ocean thermal electric conversion (OTEC) methods: Open cycle and Closed cycle Principles of tidal	8 Hrs	8 Marks	• Utilize diagrams, animations, or videos to illustrate the principles of OTEC, tidal power generation, and geothermal energy.

	power generation-Advantages and limitations of tidal power generation. Geothermal Energy: Types of Geothermal resources- Applications of Geothermal Energy.			• Present case studies highlighting successful projects or installations of OTEC, tidal power, or geothermal energy for practical insights.

References	1. *Non-Conventional Energy Resources* by B. H. Khan, McGraw Hill Education, New Delhi. 2. *Geothermal Energy* by Kriti Yaav, Anirbid Sirkar, and Apurwa Yadav, CRC Press. 3. *Fundamentals and Applications of Renewable Energy* by Mehmet Kanoglu, Yunus Cengel, and John Cimbala, McGraw Hill Education. 4. *Non-Conventional Energy Resources* by S. Hasan Saeed and D. K. Sharma, Katson Books, New Delhi. 5. *Understanding Biomass Energy* by Baby Professor, Speedy Publishing LLC. 6. *Biomass as Renewable Source of Energy* by Bibhuprasad Ganthia, Selva Suman Ray, Asutosh Parida, and Maitri Mallick, CRC Press. 7. *Non-Conventional Energy Resources* by G. D. Rai, Khanna Publishers, New Delhi. 8. *Non-Conventional Energy Resources* by Shobhnath Singh, Pearson Education, New Delhi. 9. *Wind Energy: Theory and Practice* by Siraj Ahmed, PHI Learning Pvt. Ltd., New Delhi. 10. *Future Power, Future Energy: Wind Power* by Richa Sharma, Pearson Longman Publications. 11. *Fuel Cell, Geothermal Energy and Tidal Power* by Sameer Zodgekar, ICFAI University Press, Hyderabad. 12. *Solar Energy: Fundamentals and Applications* by H. P. Garg and J. Prakash, Tata McGraw-Hill Education, New Delhi. 13. *Renewable Energy: Engineering and Technology – Principles and Practice* by S. P. Sukhatme and J. K. Nayak, Tata McGraw-Hill Education, New Delhi.

Model questions for theory external/ internal examination.	
Very Short Answer Questions (1 Mark)	1. Define renewable energy. 2. What is a fuel cell? 3. Define solar constant. 4. What is OTEC? 5. Define geothermal energy.
Short Answer Questions (3 Marks)	1. Explain the principle of a fuel cell. 2. Differentiate between flat plate and concentrating collectors. 3. Explain the advantages of wind energy. 4. Discuss applications of geothermal energy. 5. Explain tidal energy generation.
Long Answer Questions (6 Marks)	1. Explain the construction and working of solar energy collectors. 2. Discuss the working and applications of fuel cells. 3. Explain wind energy conversion systems with advantages and disadvantages. 4. Describe ocean thermal energy conversion methods. 5. Discuss the importance of non-conventional energy resources in sustainable development.

Physics SEC-1 Lab/ Practical – 129205	
Mathematical and Measurement Skills	
Credits: 02	**Workload (Hrs./Week): 04**
Course Objectives:	1. To develop fundamental understanding of trigonometry, matrices, determinants, vectors, and coordinate geometry required for physics applications. 2. To introduce mathematical techniques useful in solving basic physical and geometrical problems. 3. To familiarize students with vector operations and analytical geometry for applications in mechanics and physical sciences. 4. To provide knowledge of measurement systems, measuring instruments, and error analysis used in experimental physics. 5. To enhance analytical, computational, and problem-solving skills necessary for higher studies in physics.
Course Outcomes:	After completing the course, the student will be able to: 1. Apply trigonometric identities, matrices, determinants, and vector algebra to solve mathematical and physical problems. 2. Analyze straight lines, circles, and conic sections using principles of coordinate geometry. 3. Perform vector operations and interpret their applications in mechanics and geometry. 4. Understand measurement techniques, characteristics of measuring instruments, and methods of error estimation in experiments. 5. Solve numerical problems systematically and develop quantitative reasoning skills relevant to B.Sc. Physics.

Unit	Theoretical Background	Lab/ Practical/ Demonstrations/Activities
I	**Trigonometry:** Measurement of angles, degree and radian systems and their conversion; Trigonometric ratios and their definitions, signs of trigonometric ratios in different quadrants, trigonometric ratios of standard, negative and allied angles; Fundamental trigonometric identities and relations between trigonometric functions; Verification of identities; addition and subtraction formulae, double and half angle formulae, factorization and transformation formulae, product-to-sum and sum-to-product formulae; Inverse trigonometric functions; Graphs of trigonometric functions, amplitude, period and phase difference; Relation between sin and cos functions and simple applications of trigonometric graphs.	1. Conversion of angles between degree and radian systems. 2. Verification of trigonometric ratios and identities for standard angles. 3. Verification of addition and subtraction formulae of trigonometric functions. 4. Verification of double angle and half angle formulae. 5. Plotting graphs of sin x, cos x, and tan x and studying their properties. 6. Determination of amplitude, period, and phase difference from trigonometric graphs. 7. Study of inverse trigonometric functions and principal values using scientific calculator/software tools. 8. Verification of addition, subtraction, and multiplication of matrices. 9. Verification of properties of transpose of matrices. 10. Identification and classification of different types of matrices. 11. Evaluation of determinants of second and third order matrices. 12. Verification of properties of determinants. 13. Determination of inverse of a matrix using different methods. 14. Solution of simultaneous linear equations using matrices and determinants. 15. Plotting of straight lines and determination of slope and intercept from graphs. 16. Verification of conditions for parallel and perpendicular lines using graphical methods. 17. Plotting circles from given equations and determination of radius and centre. 18. Plotting and study of conic sections (parabola, ellipse, and hyperbola) using graph paper or software tools.
II	**Determinants** Definition and order of determinants; Expansion of determinants; Properties of determinants; Evaluation of determinants of second and third order; Applications of determinants in solving algebraic equations. **Matrices:** Definition and notation of matrices; Order and elements of a matrix; Types of matrices: row, column, square, diagonal, scalar, unit, zero; Equality of matrices; Algebra of matrices: addition, subtraction, scalar multiplication, and multiplication of matrices; Transpose of a matrix and its properties; Determinant of a square matrix; Inverse of a matrix and its	

	properties; Solution of simultaneous linear equations using matrix method. **Straight Line:** Coordinate system and distance formula; Equation of a straight line; Slope and intercept of a line; Conditions for parallel and perpendicular lines; Angle between two lines; Properties of straight lines. **Circle:** Standard equation of a circle, General equation of a circle; Radius and centre of a circle; Properties of a circle. **Conic Sections:** Introduction to conic sections; **Parabola:** Standard equation and properties; Ellipse: standard equation and properties; Hyperbola: standard equation and properties.	
III	**Measurement:** Introduction and significance of measurement; Methods of measurement; Classification of measuring instruments; Measuring instruments and their applications, Significant figures, rounding-off. **Characteristics of Measurement Systems:** Static Characteristics: Accuracy and precision, Sensitivity, Linearity, Reproducibility and repeatability, Resolution, Threshold; Stability, Tolerance, Range and span Dynamic Characteristics: Response and performance of measuring instruments	1. Determination of sensitivity, range, and least count of measuring instruments (vernier callipers, screw gauge, spherometer, thermometers, travelling microscope, spectrometer, mechanical (physical) balance, electronic balance). 2. Measurement of area, volume of a Physics lab using meter scale. 3. Measurement of length of an eraser, duster, small objects using Vernier calliper. 4. Measurement of an inner diameter of a glass tube using Vernier calliper. 5. Measurement of inner radius of curvature of a shallow objects like a steel vessel. 6. Measurement of thickness of a scale by using Screw gauge.

IV	**Errors in Measurement:** Definition and sources of errors; Types of errors in measurement: Systematic errors, Random errors, Gross errors; Limiting errors; Calculation and estimation of errors in measurement systems. **Measuring Instruments:** Determination of least count, zero error and zero correction and use of Vernier Calipers, Micrometer Screw Gauge, Spherometer, Travelling Microscope.	7. Measurement of diameter of an ear ring using screw gauge. 8. Measurement of inner and outer diameter of a capillary tube using travelling microscope. 9. Measurement of radius of curvature of a tennis ball/cricket ball by using Spherometer. 10. Measure the gravitational mass of an object by using mechanical (physical) balance. 11. Measurement of gravitational mass of an object by using electronic balance. 12. Measurement of density of water by using measuring jar and physical/electronic balance. 13. Measurement of room temperature using thermometer, express it into Kelvin, Fahrenheit. 14. Measurement of hot water by using thermometer into Celsius, Fahrenheit, Kelvin. 15. To verify law of cooling by using stopwatch and thermometer plot a graph from the observed data. Determination of refractive index of a prism by using spectrometer. 16. Determination of accuracy and precision of measuring instrument from repeated measurements. 17. Determination of errors in measurements and calculation of percentage error. 18. Statistical analysis of experimental data using mean and standard deviation. 19. Calibration and comparison of measuring instruments. 20. Observation and analysis of systematic and random errors in measurements.

Note: Every student should perform minimum 10 activities (at least 5 from Mathematical Skills and 5 from Measurement Skills).

References	1. *Mathematics Textbook for Class XI* by NCERT, NCERT Publications, New Delhi. 2. *Mathematics Textbook for Class XII* by NCERT, NCERT Publications, New Delhi. 3. *Higher Secondary Mathematics for Class XI and XII* by R. D. Sharma, Dhanpat Rai Publications, New Delhi. 4. *Senior Secondary School Mathematics* by R. S. Aggarwal, Bharati Bhawan, Patna. 5. *The Elements of Coordinate Geometry* by S. L. Loney, Arihant Publications, New Delhi. 6. *Plane Trigonometry* by S. L. Loney, Arihant Publications, New Delhi. 7. *Vector Algebra* by Shanti Narayan, S. Chand Publications, New Delhi. 8. *Schaum's Outline of College Algebra* by Murray Spiegel, McGraw Hill Education, New York. 9. *Principles of Measurement Systems* by John P. Bentley, Pearson Education, New Delhi. 10. *Physics for Degree Students: B.Sc. First Year* by C. L. Arora and P. S. Hemne, S. Chand Publications, New Delhi. 11. *Concepts of Physics, Vol. I* by H. C. Verma, Bharati Bhawan Publishers, Patna. 12. *Principles of Measurement Systems* by John P. Bentley, Pearson Education, New Delhi, 2005. 13. *Mechanical Measurements and Instrumentation* by R. K. Jain, Khanna Publishers, New Delhi, 2014. 14. *A Course in Electrical and Electronic Measurements and Instrumentation* by A. K. Sawhney, Dhanpat Rai & Co., New Delhi, 2015. 15. *Experimental Physics* by R. K. Shukla and Anchal Srivastava, New Age International Publishers, New Delhi, 2006. 16. *Advanced Practical Physics for Students* by B. L. Flint and H. T. Worsnop, Asia Publishing House, New Delhi. 17. *Practical Physics* by Brij Lal and N. Subrahmanyam, S. Chand Publications, New Delhi.

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI

FACULTY: Science and Technology
Subject: PHYSICS
Teaching and Learning Scheme for the Degree of Bachelor of Science (B.Sc.)
Three Years / Four Years - (Six/Eight Semesters) Bachelor Degree Programme

FIRST YEAR: Level 4.5 - SEMESTER – II (T & L Credit Scheme)

Mode of Teaching	Vertical No	The Vertical	Type of Course	Course Code	Course Name	Credits	Workload (Hrs/Week)	Vertical Workload (Hrs/Week)
Classroom Teaching/ Lab Work (Practical/ Outdoor/ Field/Online /Hybrid)	A	Major	Physics MJ Theory – 2	129206	Oscillations and Properties of Matter	2	2	**6**
			Physics MJ Lab/ Practical – 2	129207	Experiments Related to Oscillations and Properties of Matter	2	4	
	B	Minor	Physics MN Theory – 2	129206	Oscillations and Properties of Matter	2	2	**6**
			Physics MN Lab/ Practical – 2	129207	Experiments Related to Oscillations and Properties of Matter	2	4	
	C	Generic Open Elective	Physics OE – 3	129208	Medical Physics	2	2	**4**
			Physics OE – 4	129209	Physics Behind Everyday Life	2	2	
	D	VSC	Physics VSC – 1 Lab/Practical	129210	Electric Technician-I	2	4	**8**
		SEC	Physics SEC – 2 Lab/Practical	129211	Mathematical and Instrumentation Skills	2	4	
	E	AEC	-	-	-	*2*	*2*	***4***
		IKS	-	-	-	-	-	
		VEC	-	-	-	*2*	*2*	
	F	Int./App. /OJT	-	-	-	-	-	***4***
		FP/ CEP	-	-	-	-	-	
		CC	-	-	-	*2*	*4*	
TOTAL						**22**	**32**	**32**

Physics MJ/MN Theory 2 – 129206	
Oscillations and Properties of Matter	
Credits : 02	**Workload (Hrs/Week) : 02**
Course Objectives:	1. To define simple harmonic motion and identify its characteristics. 2. To relate simple harmonic motion to real-world examples. 3. To describe the oscillatory motion of a mass-spring system and a simple pendulum. 4. To define elasticity and understand the behavior of elastic materials. 5. To explore real-world examples of elasticity in engineering and materials science. 6. To explore the molecular basis of surface tension. 7. To explore applications of surface tension in everyday life and various industries.
Course Outcomes:	At the end of the course, students will be able to: 1. Understand the mathematical representation of simple harmonic motion using equations and graphs. 2. Relate position, velocity and acceleration in simple harmonic motion. 3. Relate the phase of motion to velocity and acceleration. 4. Apply the principles of simple harmonic motion to real-world applications. 5. Interpret stress-strain curves for different materials. 6. Differentiate between elastic and plastic deformation. 7. Understand how elasticity varies in different materials (metals, polymers, ceramics) 8. Differentiate between cohesive and adhesive forces. 9. Identify and explain the role of surface tension in everyday phenomena, such as soap bubbles, wetting of surfaces, etc.

Unit	Contents	Work-load Allotted	Weight-age of Marks Allotted	Incorporation of Pedagogies
I	**Simple Harmonic Motion-I:** Oscillatory and simple harmonic motion, differential equation of SHM and its solution, velocity and acceleration of simple harmonic oscillator, Graphical representation of displacement, Velocity and acceleration. Period and frequency of SHM, energy of a simple harmonic oscillator. Examples of simple harmonic oscillators: Spring-mass system, Simple pendulum, Compound pendulum, Torsion pendulum, Numerical.	8 Hrs	8 Marks	• Conduct experiments with springs, pendulums, or simulation software to illustrate SHM characteristics. • Engage students in solving problems involving SHM equations, energy calculations, and period/frequency determination. • Use animations, diagrams, and real- world examples to visually depict SHM concepts and oscillatory motion.
II	**Simple Harmonic Motion-II:** Resultant of two SHMs in the same direction, Lissajous' figures, graphical method for Lissajous' figures. Damped harmonic oscillator: damping force, Differential equation of motion of a damped harmonic oscillator and its solution. Forced harmonic oscillator: Differential equation for forced harmonic oscillator and its solution, Numerical.	7 Hrs	8 Marks	• Provide mathematical demonstrations and derivations for finding resultant SHMs, Lissajous figures, and solutions to differential equations. • Use interactive simulations or graphical representations to demonstrate Lissajous figures, damped and forced harmonic oscillations. • Relate examples of damped and forced oscillations to practical scenarios, such as mechanical systems with damping or resonance effects.
III	**Elasticity:** Different types of elasticity, twisting couple on a cylindrical rod or wire, Determination of modulus of	8 Hrs	8 Marks	• Use diagrams, animations, or videos to illustrate the concepts of beam bending, twisting forces, and different types of elasticity.

	rigidity by Maxwell needle, Beam: Bending of beam, Bending moment, External and internal bending moments, Cantilever, Expression for depression of a beam (i) Loaded at one end and (ii) Loaded at the center, Numerical.			• Conduct experiments or demonstrations to showcase beam bending or torsional rigidity using simple setups or models. • Engage students in solving problems related to beam bending, modulus of rigidity, and depression in beams to reinforce understanding. • Relate these concepts to real-world examples such as bridge structures, materials testing, or engineering design.
IV	**Surface Tension:** Introduction, Molecular theory of surface tension, Surface film, Surface energy, Excess pressure inside drop and soap bubble, Contact angle, Rise of liquid in a capillary tube, Viscosity: Poiseuille's equation, Stokes' law, Terminal velocity, Critical velocity and Reynolds number, Numerical.	7 Hrs	8 Marks	• Use animations, diagrams, or experiments to illustrate surface tension, capillary rise, and viscosity concepts. • Engage students in solving problems using equations like Poiseuille's and Stokes' laws to understand fluid flow and viscosity. • Relate these concepts to real-life scenarios, such as the behavior of liquids in biological systems, engineering, or everyday phenomena.

References:	1. *An Introduction to Mechanics* by Daniel Kleppner and Robert J. Kolenkow, McGraw-Hill Education, New Delhi. 2. *Physics* by David Halliday, Robert Resnick, and Jearl Walker, Wiley India Pvt. Ltd., New Delhi. 3. *Analytical Mechanics* by G. R. Fowles and G. L. Cassiday, Cengage Learning India Pvt. Ltd., New Delhi. 4. *The Feynman Lectures on Physics, Vol. I* by Richard P. Feynman, Robert B. Leighton, and Matthew Sands, Pearson Education, New Delhi. 5. *University Physics* by Francis W. Sears, Mark W. Zemansky, and Hugh D. Young, Addison-Wesley Publications, New York.

	6. *Mechanics and Properties of Matter* by D. S. Mathur, S. Chand & Company Pvt. Ltd., New Delhi. 7. *Properties of Matter* by Brij Lal and N. Subrahmanyam, S. Chand Publications, New Delhi. 8. *Elements of Properties of Matter* by D. S. Mathur, S. Chand Publications, New Delhi. 9. *Oscillations and Waves* by Satya Prakash and Vinay Dua, Pragati Prakashan, Meerut. 10. *Fundamentals of Physics* by Jearl Walker, David Halliday, and Robert Resnick, Wiley India Pvt. Ltd., New Delhi. 11. *Waves and Oscillations* by N. K. Bajaj, Tata McGraw-Hill Education, New Delhi. 12. *Properties of Matter and Acoustics* by R. Murugeshan, S. Chand & Company Pvt. Ltd., New Delhi. 13. *A Textbook of Oscillations, Waves and Acoustics* by M. Ghosh, New Central Book Agency, Kolkata. 14. *Engineering Physics* by M. N. Avadhanulu and P. G. Kshirsagar, S. Chand Publications, New Delhi. 15. *College Physics* by Raymond A. Serway and Jerry S. Faughn, Cengage Learning, New Delhi.

Model questions for theory external/ internal examination.	
One sentence/ Very short answer questions	1. Define simple harmonic motion. 2. Define periodic motion. 3. What is surface tension? 4. Define viscosity. 5. What is Young's modulus?
Short answer questions	1. Explain energy conservation in SHM. 2. Describe Lissajous figures. 3. Differentiate between elastic and plastic deformation. 4. Explain capillary rise. 5. Define Reynolds number and its significance.
Long answer questions	1. Derive the expression for the time period of a simple pendulum. 2. Explain damped harmonic motion with differential equation. 3. Derive an expression for bending of a beam loaded at the center. 4. Explain Poiseuille's equation and its applications. 5. Discuss surface tension and derive the expression for excess pressure inside a soap bubble.

<table>
<tr><th colspan="2">Physics MJ/MN Lab/ Practical 2 – 129207</th></tr>
<tr><th colspan="2">Experiments related to Oscillations and Properties of Matter</th></tr>
<tr><th>Credits: 02</th><th>Workload (Hrs./Week): 04</th></tr>
<tr><td>Course Objectives:</td><td>1. To develop understanding of oscillatory motion, elasticity, surface tension, viscosity, and fluid dynamics through laboratory experiments.
2. To impart practical knowledge of determining elastic constants such as Young's modulus and modulus of rigidity using different experimental techniques.
3. To familiarize students with experimental methods for studying properties of liquids including surface tension and viscosity.
4. To develop skills in handling precision instruments, taking accurate measurements, and interpreting experimental observations.
5. To enhance analytical ability, scientific reasoning, and experimental competence in mechanics and properties of matter.</td></tr>
<tr><td>Course Outcomes:</td><td>On successful completion of this Practical course, the students will be able to:
1. Students will analyze oscillatory systems such as spring combinations, Helmholtz resonator, bifilar suspension, and torsional pendulum arrangements.
2. Students will determine elastic constants including Young's modulus and modulus of rigidity using vibration, bending, cantilever, optical lever, Maxwell's needle, and torsional methods.
3. Students will determine surface tension and viscosity of liquids using standard experimental methods such as Quinke's, Jaeger's, capillary rise, Poiseuille's, Stoke's, and rotating cylinder methods.
4. Students will study collision phenomena and evaluate the coefficient of restitution for inelastic collisions.
5. Students will demonstrate proficiency in experimental techniques, data analysis, graphical representation, error estimation, and scientific reporting related to mechanics and properties of matter.</td></tr>
</table>

List of Experiments: Perform at least eight (8) experiments from the given list.
1. To study the oscillations of a mass in combinations of two springs. 2. To show that frequency of a Helmholtz resonator varies inversely as the square root of its volume and to estimate the neck correction. 3. To determine Young's modulus of the material of a beam by method of vibration. 4. To determine Young's modulus of the material of a beam by method of bending. 5. To determine Young's modulus of the material of a beam by a cantilever. 6. To determine Young's Modulus of a Wire by Optical Lever Method. 7. To determine modulus of rigidity of material of a given wire by Maxwell's needle. 8. To determine modulus of rigidity of material of a given wire by using Torsional pendulum. 9. To determine coefficient of restitution for inelastic collision. 10. To determine the surface tension of mercury by Quinke's method. 11. To study oscillations in Bifilar suspension arrangement. 12. To determine the surface tension of a liquid by Jaeger's method. 13. To determine the surface tension of a liquid by capillary rise method. 14. To determine the coefficient of viscosity of water by Poiseuille's flow method. 15. To determine the coefficient of viscosity of glycerin by Stoke's method. 16. To determine the coefficient of viscosity of glycerin by rotating cylinder method.

References	1. *B.Sc. Practical Physics* by Harnam Singh and P. S. Hemne, S. Chand & Company Pvt. Ltd., New Delhi. 2. *Textbook of Practical Physics* by H. P. Shrivastava, ABD Publishers, Jaipur. 3. *B.Sc. Practical Physics* by C. L. Arora, S. Chand & Company Pvt. Ltd., New Delhi. 4. *Practical Physics* by S. L. Gupta and V. Kumar, Pragati Prakashan, Meerut. 5. *University Practical Physics* by D. C. Tayal, Himalaya Publishing House, Mumbai. 6. *Practical Physics* by Brij Lal and N. Subrahmanyam, S. Chand Publications, New Delhi. 7. Amrita Virtual Labs – https://vlab.amrita.edu/ 8. Virtual Labs India – https://www.vlab.co.in/

<table>
<tr><th colspan="2">Physics OE-3 Theory – 129208</th></tr>
<tr><th colspan="2">Medical Physics</th></tr>
<tr><th>Credits: 02</th><th>Workload (Hrs./Week): 02</th></tr>
<tr><td>Course Objectives:</td><td>1. To introduce the applications of physics principles in the human body and medical science.
2. To understand the physical concepts related to body mechanics, heat, pressure, respiration, and cardiovascular systems.
3. To study electrical activities in the human body and their medical applications such as ECG and patient monitoring.
4. To understand the principles and applications of diagnostic X-rays and radiation therapy.
5. To develop basic knowledge of medical physics instruments and healthcare technologies.</td></tr>
<tr><td>Course Outcomes:</td><td>After completing the course, the student will be able to
1. Explain the role of physics in body mechanics, temperature regulation, and pressure systems in the human body.
2. Describe the physics of respiratory and cardiovascular systems and methods of related measurements.
3. Understand electrical activities of nerves and muscles and interpret basic ECG waveforms.
4. Explain the working principles of diagnostic X-ray systems and radiation therapy techniques.
5. Apply basic medical physics concepts to healthcare, diagnostic, and biomedical applications.</td></tr>
</table>

Unit	Contents	Workload Allotted	Weightage of Marks Allotted	Incorporation of Pedagogies
I	Mechanics Of Human Body, properties and functions of Bone, Heat and Temperature, Temperature scales, Clinical thermometer, thermography, Heat therapy, Cryogenics in medicine, Heat losses from body, Pressure in the Body, Pressure in skull, Eye and Urinary Bladder.	7 Hrs.	8 Marks	• Multimedia and Visual Aids, • Case- Based Learning and Collaborative Learning
II	Physics of Respiratory and Cardiovascular System Body as a machine, Airways, Blood and Lungs interactions, Measurement of Lung volume Breathing mechanism, blood pressure, direct and indirect method of measuring	8 Hrs.	8 Marks	• Interdisciplinary Approach, Practical Demonstrations and • Case-Based Learning
III	Electricity in the Body Nervous system and Neuron – Electrical potentials of Nerves, Electric signals from Muscles, Normal ECG waveform, Amplifier and Recording device – Block diagram and working to record ECG, Patient monitoring.	8 Hrs.	8 Marks	• Connect biological concepts of the nervous and cardiovascular systems with electrical principles to create a comprehensive understanding. • Visualization and Simulations.
IV	Diagnostic X- Rays, properties of X- rays, Basic Diagnostic X-ray Machine, X-ray image, Live X-ray image, Radioactivity sources for nuclear, Principles of Radiation Therapy.	7 Hrs.	8 Marks	• Visual Aids and Simulations. • Interactive Learning and Ethical Discussions

References:	1. *Medical Physics* by John R. Cameron and James G. Skofronick, Wiley-Interscience Publications, New York, 1978. 2. *Handbook of Biomedical Instrumentation* by R. S. Khandpur, Tata McGraw-Hill Publishing Company, New Delhi, 1987. 3. *Biomedical Instrumentation* by M. Arumugam, Anuradha Agencies Publishers, Kumbakonam. 4. *Physics in Biology and Medicine* by Paul Davidovits, Academic Press Publications.

Model questions for theory external/ internal examination.	
Very Short Answer Questions (1 Mark)	1. Define thermography. 2. What is ECG? 3. Define blood pressure. 4. What are X-rays? 5. Define cryogenics.
Short Answer Questions (3 Marks)	1. Explain heat loss from the human body. 2. Describe breathing mechanism. 3. Explain electrical signals in nerves. 4. Discuss applications of X-rays in diagnosis. 5. Explain patient monitoring systems.
Long Answer Questions (6 Marks)	1. Explain the physics of the respiratory system. 2. Discuss ECG recording with block diagram. 3. Explain the construction and working of a basic X-ray machine. 4. Describe applications of cryogenics in medicine. 5. Discuss the role of physics in medical sciences.

Physics OE-4 Theory – 129209	
Physics Behind Everyday Life	
Credits: 02	**Workload (Hrs./Week): 02**
Course Objectives:	1. To develop a fundamental understanding of basic physics concepts related to transportation, sports, weather, climate, and home electricity. 2. To apply principles of mechanics, thermodynamics, and electricity in analyzing day-to-day phenomena and practical situations. 3. To enhance scientific reasoning and problem-solving abilities through numerical applications and conceptual understanding. 4. To prepare students for various competitive examinations by strengthening their understanding of applied physics concepts commonly asked in aptitude and general science sections. 5. To create awareness about the role of physics in technology, safety, environmental studies, energy conservation, and human activities.
Course Outcomes:	After completing the course, the student will be able to 1. Explain the principles of motion, force, energy, momentum, friction, and collisions involved in transportation systems and daily life applications. 2. Analyze the role of projectile motion, rotational dynamics, moment of inertia, and angular momentum in sports activities and athletic performance. 3. Describe the concepts of heat, temperature, thermodynamics, heat transfer, and black body radiation in relation to weather and climate phenomena. 4. Understand the fundamentals of electricity including electrostatics, electric current, resistance, Ohm's law, electric power, refrigeration, and electrical safety used in household applications. 5. Solve conceptual and numerical problems useful for competitive examinations such as MPSC, UPSC, SSC, Railway, Police Recruitment, Banking Aptitude, and various entrance examinations.

Unit	Contents	Workload Allotted	Weightage of Marks Allotted	Incorporation of Pedagogies
I	**Transportation:** Linear motion, Speed, velocity, acceleration, Force, Newton's laws, circular motion, friction, collision, energy and momentum.	8 Hrs	8 Marks	• Interactive Demonstrations, Graphical Representation and Problem-Solving Approach
II	**Sports:** Force, energy, projectile motion, rotation, moment of inertia, angular momentum.	7 Hrs	8 Marks	• Hands-On Activities, Interactive Demonstrations, Real-Life Connections and Problem-Based Learning
III	**Weather and Climate:** Energy, heat and temperature, the first law thermodynamics, heat transfer, black body radiation	7 Hrs	8 Marks	• Use visual aids, hands-on experiments, and verbal explanations to accommodate different learning styles and Field Trips or Observations
IV	**Home Electricity:** Electrostatics, electric potential, current, and resistance, ohm's law, electric power, refrigeration, electric safety.	8 Hrs	8 Marks	• Real-Life Applications, Problem-Based Learning and use of Visual and Interactive Materials

References:	1. *Physics Beyond the Comfort Zone* by Peter Watson, Morgan & Claypool Publishers. 2. *Concepts of Physics, Vol. I and II* by H. C. Verma, Bharati Bhawan Publishers, Patna. 3. *Physics for Degree Students* by C. L. Arora and P. S. Hemne, S. Chand Publications, New Delhi. 4. *Everyday Physics* by Bhaskar Chatterjee, Books and Allied Pvt. Ltd., Kolkata. 5. *भौतिकशास्त्र* by Dr. B. B. Deshpande, Vidya Books Publishers, Nagpur. 6. *उपयोजित भौतिकशास्त्र* by Dr. P. S. Patil, Prashant Publications, Jalgaon. 7. *सामान्य विज्ञान व भौतिकशास्त्र* b y Prof. Anil Deshmukh, Unique Academy Publications, Pune. 8. *स्पर्धा परीक्षांसाठी विज्ञान* by Dr. Sunil Gorivale, Chaitanya Publications, Nashik. 9. *सामान्य विज्ञान* by Arihant Experts, Arihant Publications, Meerut.

Model questions for theory external/ internal examination.	
Very Short Answer Questions (1 Mark)	1. Define momentum. 2. State Newton's second law. 3. Define electric power. 4. What is friction? 5. Define projectile motion.
Short Answer Questions (3 Marks)	1. Explain circular motion in transportation. 2. Discuss the role of angular momentum in sports. 3. Explain heat transfer in weather systems. 4. Describe electric safety at home. 5. Explain refrigeration.
Long Answer Questions (6 Marks)	1. Explain applications of Newton's laws in transportation. 2. Discuss the role of physics in sports activities. 3. Explain thermodynamics in climate and weather systems. 4. Describe home electrical wiring and safety measures. 5. Evaluate the importance of physics in daily life.

Physics VSC-1 Lab/Practical – 129210	
Electric Technician-I	
Credits: 02	**Workload (Hrs./Week): 04**
Course Objectives:	1. To develop awareness about electrical safety practices, emergency handling, and elementary first aid procedures. 2. To impart knowledge of basic electrical concepts, electrical materials, and simple electrical circuits. 3. To train students in the identification, handling, maintenance, and application of electrical tools, wires, cables, and accessories. 4. To develop practical skills in soldering, wiring, testing, and measurement techniques using electrical instruments and meters. 5. To enhance vocational competency, technical skills, and employability in electrical maintenance and allied areas of physics.
Course Outcomes:	After completing the course, the student will be able to: 1. Demonstrate safe working practices and apply elementary first aid and emergency response procedures in electrical environments. 2. Identify and appropriately use electrical tools, wires, cables, and accessories for basic electrical applications. 3. Explain and apply fundamental electrical concepts such as current, voltage, resistance, power, and Ohm's law in simple circuits. 4. Perform soldering, wiring, insulation testing, and electrical measurements using standard instruments and meters. 5. Acquire vocational and technical skills relevant to electrical maintenance, instrumentation, self-employment, and allied fields of physics.

Unit	Theoretical Background	Lab/ Practical/ Demonstrations/Activities
I	**Basic Tools & Safety** • Familiarization with trade, safety precautions, and elementary first aid. • Identification and care of hand tools with their specifications. • Response to emergencies (power failure, system failure, fire) and safety signs. • Introduction to Standards (BIS/ISI) and advantages.	1. Hands-on identification and understanding of commonly used hand tools. 2. Setting up toolkit with various hand tools. 3. Demonstrations: Proper handling, use, and maintenance of tools. 4. Demonstrations: Practical steps and protocols to follow in each emergency situation like power failure, system failure, and fire. 5. Presentation on BIS/ISI standards, safety signs, and their meanings. Demonstrations on treating minor cuts, burns, and electric shock.
II	**Fundamentals of Electricity** • Definitions, units, and effects of electric current. • Voltage, current, resistance, and power concepts. • Use of multimeter • Ohm's law and circuit combinations (series, parallel, series-parallel). • Differences between AC and DC, conductors, insulators, and conducting materials. • Techniques of soldering and types of solders.	7. Setting up basic circuits with varying current strengths and measuring current using ammeters. 8. Building circuits with different resistors and power sources and voltage, current, and calculation of power using multi- meters and Ohm's law. 9. Constructing series and parallel circuits with resistors and measuring of voltage, current, and resistance in series and parallel setups. 10. Demonstration of differences of AC and DC with reference to behavior and characteristics of some basic electrical devices in AC and DC circuits. 11. Demonstration of proper soldering methods, solder types, and safety precautions. 12. Practical soldering exercises on circuit boards or connectors. 13. Prepare a chart of wattage of different electrical items/appliances like CFL bulb, LED bulb, Tube light, Ceiling Fan, Table Fan, Gyger, Mixer-grinder, Refrigerator, Water pump, Iron, Xerox Machine, Inverter, TV, Hanging/ pendant Light, Microwave oven etc.

III	**Electrical Wires & Cables** • Identification and uses of various wires used in house wiring, motor winding, and appliances. Joints, testing procedures, insulation, and voltage grades. • Underground cables: types, joints, testing procedures, insulation, and voltage grades. • Understanding voltage drop and losses across cables. • Instruments to measure current, voltage, power in DC and AC circuits.	14. Identification and classification of wires (1/27, 3/22, 3/20 Copper, 1.3, 2.5 and 4 mm2 Aluminum, V.I.R., P.V.C., C.T.S., Lead covered, Enameled, Super Enameled Wire, Earthing Wire (G.I and Copper), Guide Wire. 15. Demonstration: Testing procedures for insulation resistance and continuity checks. 16. To measure the gauge of a given wire with the help of a wire gauge. 17. Measurement of voltage drop using voltmeters and calculation of losses. 18. Simulation of voltage drop across cables of varying lengths and materials. 19. Hands on experience of use of muti-meters, clamp meters, and power meters to measure current, voltage, and power in DC and AC circuits. 20. Skinning the cable and joint practice on single and multi- strand wire.
IV	**Electric Accessories & Meters** • Installation and specifications of electric meters and common accessories. • Functions and uses of ammeters, voltmeters, energy meters, and wattmeters. • Introduction to Megger and its applications.	21. Demonstration of mounting and installation of various types of electric meters. 22. Uses of energy meters and watt-meters in electrical circuits. 23. Use of the Megger for insulation resistance testing in circuits. 24. Simulation of complex electrical circuits with faults. 25. Troubleshooting faults using meters and Megger for diagnosis.

Note: Students should at least perform 10 Lab/ Practical/ Demonstrations/Activities.

References:	1. *Textbook of Electrical Technology, Vol. I* by B. L. Theraja and A. K. Theraja, S. Chand Publications, New Delhi. 2. *National Electrical Code 2011* by Bureau of Indian Standards (BIS), New Delhi. 3. *Electrical Wiring: An Introduction* by Satheesh Kumar, ANE Books Pvt. Ltd., New Delhi. 4. *Electrical Wiring, Estimating and Costing* by S. L. Uppal and G. C. Garg, Khanna Publishers, New Delhi.

	5. *Electrical Home Appliances with Electric Wiring* by Surjit Singh, Dhanpat Rai Publications, New Delhi. 6. *Electrical Technician Handbook for Intermediate Vocational Course* by Made Easy Publications, New Delhi, 2023. 7. *Basic Electrical Engineering* by V. K. Mehta and Rohit Mehta, S. Chand Publications, New Delhi. 8. *Installation, Testing and Commissioning of Electrical Installations* by J. B. Gupta, S. K. Kataria & Sons, New Delhi. 9. Electrical and Electronic Measurements and Instrumentation – A. K. Sawhney, A Course in Electrical and Electronic Measurements and Instrumentation, Dhanpat Rai Publications.

<table>
<tr><th colspan="2">Physics SEC-2 Lab/ Practical – 129211</th></tr>
<tr><th colspan="2">Mathematical and Instrumentation Skills</th></tr>
<tr><th>Credits: 02</th><th>Workload (Hrs./Week): 04</th></tr>
<tr><td>Course Objectives:</td><td>1. To develop understanding of complex numbers and their applications in mathematical and physical problems.
2. To introduce the fundamental concepts of differential and integral calculus required in physics.
3. To familiarize students with differential equations and their applications in physical systems.
4. To develop analytical and problem-solving skills through mathematical methods and numerical applications.
5. To provide the mathematical foundation necessary for advanced studies in B.Sc. Physics and related disciplines.</td></tr>
<tr><td>Course Outcomes:</td><td>After completing the course, the student will be able to:
1. Perform algebraic operations on complex numbers and apply De Moivre's theorem in solving mathematical problems.
2. Apply differentiation and integration techniques to solve problems related to mathematics and physics.
3. Solve first-order differential equations and interpret their applications in radioactive decay and mechanics.
4. Analyze functions using derivatives, partial differentiation, and definite integrals.
5. Develop quantitative reasoning and computational skills required for higher-level physics and mathematical studies.</td></tr>
</table>

Unit	Theoretical Background	Lab/ Practical/ Demonstrations/Activities
I	**Complex Numbers:** Complex and imaginary numbers; Algebra of complex numbers; Addition, subtraction, multiplication, division, and scalar multiplication of complex numbers; Conjugate of a complex number and its properties; Modulus and amplitude (argument) of a complex number; Argand diagram and geometrical representation of complex numbers; Polar form of a complex number; De Moivre's theorem and its applications; Powers and roots of complex numbers; Square root of a complex number; Solution of quadratic equations using complex numbers; Simple numerical problems based on complex numbers	1. Representation of complex numbers on the Argand diagram. 2. Verification of algebraic operations on complex numbers: addition, subtraction, multiplication, and division. 3. Determination of modulus and amplitude (argument) of complex numbers. 4. Conversion of complex numbers from Cartesian form to polar form and vice versa. 5. Verification of properties of conjugate of a complex number. 6. Application of De Moivre's theorem for finding powers and roots of complex numbers. 7. Determination of square roots of complex numbers and solution of quadratic equations using complex numbers. 8. Verification of derivatives of algebraic and trigonometric functions using graphical methods. 9. Determination of slope and tangent of a curve at different points using differentiation. 10. Numerical evaluation of derivatives of standard and inverse trigonometric functions. 11. Verification of partial derivatives for functions of two variables. 12. Numerical problems based on parametric differentiation. 13. Verification of standard integrals and simple methods of integration. 14. Evaluation of definite integrals graphically and numerically. 15. Applications of definite integration for calculation of area under curves.
II	**Differentiation:** Introduction to differentiation; Derivatives of algebraic and standard functions; Derivatives of trigonometric and inverse trigonometric functions; Derivatives of parametric functions; Partial differentiation; Important derivative formulae; Physical significance and applications of derivatives; Numerical problems based on differentiation **Integration:** Introduction to integration; Indefinite integration and Simple methods of integration; Standard integrals and important results; Definite integration and its properties; Applications of definite integration **Differential Equations:** Introduction to differential equations; Formation and solution of first-order differential equations; Basic idea of second-order differential equations; Applications of differential equations: Radioactive decay and half-life period, Newton's laws of motion; Partial differential equations.	

		16. Computer/software-based plotting of functions and study of derivatives and integrals. 17. Formation of simple first-order differential equations from physical situations. 18. Solution of first-order differential equations by analytical methods. 19. Numerical problems based on growth and decay equations. 20. Study of radioactive decay law and determination of half-life using graphical methods. 21. Applications of differential equations to Newton's laws of motion. 22. Verification of exponential decay behavior using simulated or experimental data. 23. Introduction to second-order differential equations through simple harmonic motion models. 24. Demonstration of partial differentiation for functions of two variables. 25. Computer/software-based plotting of solutions of differential equations.
III	**Overview of Measuring Instruments - I:** Multimeter: Introduction to multimeter; Types of multimeters: analog and digital; Specifications of a multimeter and their significance; Measurement of voltage, current, and resistance using multimeter; Introduction to function generator	26. Identification of different types of multimeters and their specifications. 27. Measurement of DC and AC voltage using analog and digital multimeters. 28. Measurement of current and resistance using multimeter. 29. Verification of continuity and testing of electrical components using multimeter. 30. Study of block diagram and front panel controls of CRO. 31. Identification and study of different parts of Cathode Ray Tube (CRT). 32. Observation of sinusoidal, square, and triangular waveforms using CRO.
IV	**Overview of Measuring Instruments - II:** CRO: Introduction and applications of CRO; Block diagram of CRO; Construction and working of Cathode Ray Tube (CRT); Electron gun and fluorescent screen; Front panel controls and their functions; Basic waveform observation using CRO.	

		33. Measurement of amplitude and time period of waveforms using CRO. 34. Study of effect of front panel controls on waveform display in CRO. 35. Comparison of analog and digital measuring instruments based on observations. 36. To study Lissajous figures to know about the Phase difference between the two signals and the ratio of their frequencies by using CRO. 37. Testing of parameters of Semiconductor Diode and Bipolar Junction Transistor by using CRO.

Note: Every student should perform minimum 10 activities (at least 5 from Mathematical Skills and 5 from Instrumentation Skills).

References:

1. *Mathematical Physics* by H. K. Dass, S. Chand & Company Pvt. Ltd., New Delhi.
2. *Mathematical Physics* by B. D. Gupta, Vikas Publishing House Pvt. Ltd., New Delhi.
3. *Mathematical Physics* by Satya Prakash, Sultan Chand & Sons, New Delhi.
4. *Vector Analysis* by Murray R. Spiegel, McGraw-Hill Education, New York.
5. *Numerical Methods* by S. S. Sastry, PHI Learning Pvt. Ltd., New Delhi.
6. *Numerical Methods in Engineering and Science* by B. S. Grewal, Khanna Publishers, New Delhi.
7. *Principles of Measurement Systems* by John P. Bentley, Pearson Education, New Delhi.
8. *Mechanical Measurements and Instrumentation* by R. K. Jain, Khanna Publishers, New Delhi.
9. *A Course in Electrical and Electronic Measurements and Instrumentation* by A. K. Sawhney, Dhanpat Rai & Co., New Delhi.
10. *Instrumentation Devices and Systems* by C. S. Rangan, G. R. Sarma, and V. S. V. Mani, Tata McGraw-Hill Education, New Delhi.
11. *Electronic Instrumentation* by H. S. Kalsi, Tata McGraw-Hill Education, New Delhi.
12. *Engineering Metrology and Measurements* by N. V. Raghavendra and L. Krishnamurthy, Oxford University Press, New Delhi.
13. *Experimental Physics* by R. K. Shukla and Anchal Srivastava, New Age International Publishers, New Delhi.
14. *Practical Physics* by Brij Lal and N. Subrahmanyam, S. Chand Publications, New Delhi.
15. *Basic Electrical and Electronics Engineering* by S. K. Bhattacharya, Pearson Education, New Delhi.
16. *Digital Principles and Applications* by A. P. Malvino and Donald P. Leach, Tata McGraw-Hill Education, New Delhi.

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI

Three/Four Years – Six/Eight Semesters Bachelor's Degree Programme
3 Years B.Sc. / 4 Years B.Sc. (Hons.) & 4 Years B.Sc. (Hons. with Research) Programme

Faculty of
Science and Technology
(Science Group)

Subject: **PHYSICS**
(Semesters III and IV)

Effective from Academic Year 2026-27
(As per NEP 2020)

Contents

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI

FACULTY: Science and Technology

Subject: PHYSICS

Teaching and Learning Scheme for the Degree of Bachelor of Science (B.Sc.)

Three Years / Four Years - (Six/Eight Semesters) Bachelor Degree Programme

Examination, Evaluation and Assessment Scheme

Vertical No.	The Vertical	Mode of Examination, Evaluation & Assessment	Theory					Theory (Total)		Practical					Practical (Total)	
			External			Internal				External			Internal			
			Max. Marks	Min. Marks	Duration (Hrs.)	Max. Marks	Min. Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks	Duration (Hrs.)	Max. Marks	Min. Marks	Max. Marks	Min. Marks
A	**Major**	**External & Internal**	**30**	**9**	**2**	**20**	**6**	**50**	**20**	**25**	**10**	**3**	**25**	**10**	**50**	**20**
	IKS Major Specific		**30**	**9**	**2**	**20**	**6**	**50**	**20**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
B	**Minor**		**30**	**9**	**2**	**20**	**6**	**50**	**20**	**25**	**10**	**3**	**25**	**10**	**50**	**20**
C	**Generic/ Open Elective**	**Internal**	**-**	**-**	**-**	**50**	**20**	**50**	**20**	**--**	**--**	**-**	**--**	**--**	**--**	**--**
D	**VSC**	**Internal**	**--**	**--**	**-**	**-**	**-**	**-**	**-**	**--**	**--**	**-**	**50**	**20**	**50**	**20**
	SEC	**Internal**	**--**	**--**	**-**	**-**	**-**	**-**	**-**	**--**	**--**	**-**	**50**	**20**	**50**	**20**
F	**Internship/ Apprenticeship**	**Internal**	Assessment of these verticals shall be based on various activities/practices. It shall be evaluated by giving maximum marks of 50 per 2 Credit Course with separate activity weightages/levels. A detailed SOP for thisassessment process shall be prescribed separately.													
	FP/CEP															
	CC															

Internal Assessment for Theory/Practical/Laboratory:

All the internal assessments should be conducted on the basis of Continuous Assessment Tests (CAT).

Continuous Assessment Tests (CAT):

For internal assessment, the Continuous Assessment Tests (CAT) shall be conducted as under

i. Three CAT each of 10 Marks (Theory) and 10 Marks (Practical).
   - First on completion of 25% Syllabus of the course or on completion of 25 teaching days,
   - Second on completion of 50% Syllabus of the course or on completion of 50 teaching days,
   - Third on completion of 75% Syllabus of the course or on completion of 75 teaching days.

ii. Each concurrent assessment (CAT-I, II & III) will be mapped to relevant Course Learning Outcome.

iii. Total Performance in CAT (i.e.40 %) shall be based on the best two out of three in CAT examinations

iv. Internal assessment shall be carried out by the respective course teacher by choosing variety of assessment tools/methods such as class test, seminar, case study, field work, mini project work, quiz or any innovative method, which may be deemed to be appropriate for assessing the relevant course outcome.

External Assessment for Practical (Major/Minor Lab):

- Experiment Performance : 20 Marks
- Viva-Voce : 05 Marks
- **Total : 25 Marks**
- Duration of Examination : 03 Hrs.

Internal Assessment for Practical (Major/Minor Lab):

- Internal Assessment based on CAT : 20 Marks
- Record Book : 05 Marks
- **Total : 25 Marks**

Internal Assessment for OE:

- Internal Assessment based on CAT : 20 Marks
- End Semester Examination : 30 Marks
- **Total : 50 Marks**
- Duration of End Semester Examination : 02 Hrs.

Internal Assessment for Practical (SEC/VSC Lab):

- Internal Assessment based on CAT : 20 Marks
- Record Book : 10 Marks
- End Semester Examination : 20 Marks
  (Experiment/ Demonstration/ Hands on Activity Performance: 15 Marks + Viva-Voce: 05 Marks)
- **Total : 50 Marks**
- Duration of End Semester Examination : 03 Hrs.

Note: The external assessments of theory courses will be conducted in accordance with the guidelines issued by the SGBA University.

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI
FACULTY: Science and Technology
Subject: PHYSICS
Teaching and Learning Scheme for the Degree of Bachelor of Science (B.Sc.)
Three Years / Four Years - (Six/Eight Semesters) Bachelor Degree Programme

SECOND YEAR: Level 5.0 - SEMESTER – III (T & L Credit Scheme)

Mode of Teaching	Vertical No	The Vertical	Type of Course	Course Code	Course Name	Credits	Workload (Hrs/Week)	Vertical Workload (Hrs/Week)
Classroom Teaching/ Lab Work (Practical/ Outdoor/ Field/Online/Hybrid)	A	Major Physics MJ	Physics MJ Theory 3	129212	Mathematical Physics, Electrostatics and Magnetostatics	2	2	**10**
			Physics MJ Theory 4	129213	Solid State Devices I	2	2	
			Physics MJ Lab/ Practical 3	129214	Experiments Related to MJ Th3 and MJ Th4	2	4	
		IKS- SS	IKS-Physics Theory	129215	IKS-Physics	2	2	
	B	Minor	Physics MN Theory 3	129216	Mathematical Physics and Solid-State Devices	2	2	**6**
			Physics MN Lab/ Practical 3	129217	Experiments Related to MN Th3	2	4	
	C	Generic/ Open Elective	Physics OE-5 Theory	129218	Solar Energy and Its Applications	2	2	**2**
	D	VSC	Physics VSC-2 Lab/ Practical	129219	Electrical Installation for Residential Buildings	2	4	**4**
		SEC				-	-	
	E	AEC				2	2	**2**
		IKS (Generic)				-	-	
		VEC				-	-	
	F	FP/CEP	Physics FP/CEP-1 Project	129220	Field Project / CE Services	2	4	**8**
		CC	Outdoor	-	Separate SOP will be released	*2*	*4*	
TOTAL						**22**	**32**	**32**

Physics MJ Theory 3 – 129212	
Mathematical Physics, Electrostatics and Magnetostatics	
Credits: 02	**Workload (Hrs./Week): 02**
Course Objectives:	1. To provide students with a strong foundation in the mathematical tools essential for physics, including scalar and vector fields, gradient, divergence, curl, and integral theorems. 2. To develop an understanding of electrostatics, including electric fields, electric potential, Gauss's theorem, and their applications to various charge distributions. 3. To introduce the concept of capacitance and its applications in different configurations of capacitors, including the effects of dielectric materials. 4. To familiarize students with magnetostatics, including Biot-Savart's law, Ampere's circuital law, and their applications to current-carrying conductors and solenoids. 5. To enhance problem-solving skills through numerical applications and practical examples related to electrostatics and magnetostatics.
Course Outcomes:	By the end of the course, students will be able to: 1. Apply mathematical concepts such as gradient, divergence, curl, and integral theorems to solve physics problems. 2. Analyze and compute electric fields and potentials for various charge distributions using Gauss's theorem and other electrostatic principles. 3. Evaluate the capacitance of different capacitor configurations and understand the role of dielectric materials in capacitors. 4. Determine magnetic fields due to current-carrying conductors and solenoids using Biot-Savart's law and Ampere's circuital law. 5. Solve numerical problems related to electrostatics and magnetostatics, demonstrating a clear understanding of theoretical concepts. 6. Relate the physical significance of key concepts such as electric flux, potential, and magnetic induction to real-world applications.

Unit	Contents	Work-load Allotted	Weight-age of Marks Allotted	Incorporation of Pedagogies
I	**Mathematical Physics:** Scalar and Vector fields, Scalar and Vector product, Gradient and its physical significance, Divergence and its physical significance, Curl and its physical significance, Line integral, Surface integral and Volume integral, Gauss's divergence theorem, Stokes' theorem, Numerical.	8 Hrs.	8 Marks	• Use diagrams, simulations, or animations to illustrate: Scalar and vector fields, • Engage students with interactive simulations about Gradient, Divergence and Curl. • Explain in detail about Gauss's divergence theorem, Stokes' theorem.
II	**Electrostatics-I:** Coulomb's Law, Electric field, Electric Flux and its expression, Work done on charge in electrostatics field, Gauss's theorem, Applications of Gauss's theorem: Electric field due to point charge, infinite line of charge, uniformly charged spherical shell and uniformly charged solid sphere, Numerical.	7 Hrs.	8 Marks	• Demonstrate Coulomb's Law • Use diagrams, animations, or simulations to illustrate Electric field and Electric Flux • Engage students in discussions about Gauss's theorem. • Provide detail about Applications of Gauss's theorem.
III	**Electrostatics-II:** Electric potential, Electric potential at a point due to a point charge, Electric potential as the line integral of electric field, Relation between electric field and electric potential, Capacitors: Introduction, Capacitance of isolated spherical conductor, parallel plate capacitor, spherical & cylindrical capacitors, parallel plate capacitor with and without dielectric medium, energy of capacitor, Numerical.	7 Hrs.	8 Marks	• Use animations to illustrate concept and working of Capacitors. • Conduct experiments or Demonstrations to illustrate spherical conductor, parallel plate capacitor, spherical & cylindrical capacitors working. • Discuss and solve numerical.
IV	**Magnetostatics:** Magnetic induction (B), Magnetic field strength (H), permeability (μ), relative permeability (μ_r), Biot-Savart's law, applications to find B due to straight conductor, circular coil and Solenoid carrying current. Ampere's circuital law, applications to find B inside an infinite solenoid and near a straight conductor. Numerical.	8 Hrs.	8 Marks	• Use animations to illustrate concept of permeability, relative permeability. • Conduct demonstrations to illustrate applications of Biot-Savart's law. • Explain Ampere's circuital law and its applications.

References:	1. *Mathematical Physics* by Kakani and Hemrajani, CBS Publishers & Distributors, New Delhi. 2. *Mathematical Physics* by B. S. Rajput, Pragati Prakashan, Meerut. 3. *Physics for B.Sc. First Year* by C. L. Arora and P. S. Hemne, S. Chand & Co. Ltd., New Delhi. 4. *Electricity and Magnetism* by R. Murugeshan, S. Chand & Co. Ltd., New Delhi. 5. *Introduction to Electrodynamics* by David J. Griffiths, Pearson Education, New Delhi. 6. *Electromagnetism* by Kakani and Hemrajani, CBS Publishers & Distributors, New Delhi. 7. *Electrodynamics* by Gupta, Kumar, and Sharma, Pragati Prakashan, Meerut. 8. *Concepts of Modern Physics* by Arthur Beiser, McGraw Hill Education, New Delhi. 9. *Vector Analysis and Electrostatics* by J. P. Agrawal, Sanjay Singh, and S. A. Waghole, Pragati Prakashan, Meerut. 10. *Magnetostatics and Electromagnetic Waves* by Sanjay Singh and S. A. Waghole, Pragati Prakashan, Meerut. 11. *Mechanics and Electrodynamics* by Brij Lal and N. Subrahmanyam, S. Chand & Co. Ltd., New Delhi. 12. *Electricity and Magnetism* by Satyaprakash, Pragati Prakashan, Meerut. 13. *Classical Electrodynamics* by J. D. Jackson, Wiley Eastern Ltd., New Delhi. 14. *Electromagnetic Fields* by Dr. Murty, S. Chand & Co. Ltd., New Delhi.

Model questions for theory external/ internal examination.	
One sentence/ Very short answer questions (1 Mark)	1. Define electric flux. 2. What is the physical significance of divergence? 3. State Gauss's theorem in electrostatics. 4. Define dielectric constant. 5. What is the SI unit of magnetic induction?
Short answer questions (3 Marks)	1. Differentiate between scalar and vector fields. 2. Explain the relation between electric field and electric potential. 3. Derive the expression for capacitance of a parallel plate capacitor. 4. Explain Biot–Savart's law with one application. 5. Compare electric field inside and outside a charged conducting sphere.
Long Answer Questions (6 Marks)	1. State and prove Stokes' theorem with suitable physical interpretation. 2. Derive the expression for capacitance of a spherical capacitor. 3. Using Ampere's circuital law, derive the magnetic field inside a solenoid and discuss its practical applications. 4. Derive the relation between electric field and electric potential. 5. Compare Gauss's law and Coulomb's law in solving electrostatic problems.

Physics MJ Theory 4 – 129213	
Solid State Devices – I	
Credits: 02	**Workload (Hrs./Week): 02**
Course Objectives:	1. To introduce the fundamental concepts of semiconductors and types. 2. To explain the working principles of PN junctions, rectifiers, and their applications in power supplies. 3. To analyze the role of filter circuits in reducing ripple voltage and their design considerations. 4. To explore the characteristics and applications of Zener diodes as voltage regulators. 5. To study the construction, working principles, and applications of key semiconductor devices such as LEDs, photodiodes, varactor diodes, and SCRs. 6. To provide hands-on problem-solving experience through numerical examples and circuit analysis.
Course Outcomes:	By the end of this course, students will be able to: 1. Understand the behaviour of electrons and holes in intrinsic and extrinsic semiconductors, and calculate Fermi levels. 2. Analyze the characteristics of PN junctions under different biasing conditions and their applications in rectifiers. 3. Design basic power supply circuits incorporating rectifiers, filters, and regulators to achieve stable DC output. 4. Evaluate the performance of filter circuits (capacitor, inductor, L-section, π-section) and compute ripple factors. 5. Apply Zener diodes in voltage regulation circuits and solve related numerical problems. 6. Demonstrate the working principles of LEDs, photodiodes, varactor diodes, and SCRs in practical applications such as inverters and temperature control systems. 7. Interpret circuit diagrams and troubleshoot common issues in semiconductor-based electronic systems.

Unit	Contents	Work-load Allotted	Weight-age of Marks Allotted	Incorporation of Pedagogies
I	**Semiconductors:** Introduction, intrinsic and extrinsic semiconductors. P-type and N-type extrinsic semiconductor, majority and minority charge carriers, electron and hole concentration in intrinsic semiconductors, Fermi level in intrinsic and extrinsic semiconductors, Hall effect, expression for Hall coefficient, applications of Hall effect.	8 Hrs.	8 Marks	• Use diagrams, simulations, or animations to illustrate Semiconductor concept • Engage students with interactive simulations about Intrinsic and extrinsic semiconductors. • Provide step-by-step information about electron and hole concentration in intrinsic and extrinsic semiconductor.
II	**PN junction:** Formation of PN junction, PN junction with no bias, depletion region, barrier potential, forward bias and reverse bias of PN junction diode and characteristics. **Rectifiers:** Half wave rectifier, full-wave rectifier, bridge rectifier, comparison of rectifiers, ripple factor and efficiency of rectifiers. **Zener diode:** Zener diode (construction, biasing and characteristics), Numerical.	8 Hrs.	8 Marks	• Use diagrams, animations, or simulations to illustrate formation of PN junction. • Engage students in discussions about Rectifiers and working of different rectifier circuits. • Use animations to illustrate concept and working of different filter circuits and Zener diode. • Conduct experiments or demonstrations to illustrate construction, biasing, characteristics of Zener diode.
III	**Filter circuits:** Capacitor filter, inductor filter, L-section and π-section filter. **Power Supply:** Unregulated power supply, Zener diode as voltage regulator, line and load regulation, regulated power supply.	7 Hrs.	8 Marks	• Explain Capacitor filter, inductor filter, L-section and π- section filter. • Explain Zener diode as voltage regulator. • Explain difference between unregulated and regulated power supply.
IV	**Semiconductor Devices:** Construction, working, characteristics and applications of Light Emitting Diode (LED). Construction, working, characteristics and applications of Photodiode. Construction and working of Varactor diode. Principle, construction, working and characteristics of Silicon controlled	7 Hrs.	8 Marks	• Use animations to illustrate concept and working of Light emitting diode, Varactor diode, Silicon controlled rectifier. • Conduct experiments or demonstrations to illustrate construction, biasing, characteristics of Light emitting diode, Varactor diode and Silicon controlled rectifier.

	rectifier (SCR), applications of SCR in inverter and temperature controller (with circuit diagram).			• Demonstrate the applications of Light emitting diode, Varactor diode and Silicon controlled rectifier.

References:	1. *Basic Electronics* by B. L. Theraja, S. Chand Publications, New Delhi. 2. *Elements of Electronics* by M. K. Bagade and S. P. Singh, S. Chand Publications, New Delhi. 3. *Principles of Electronics* by V. K. Mehta, S. Chand Publications, New Delhi. 4. *Electronic Devices and Circuits* by Sanjeev Gupta, Dhanpat Rai Publications, New Delhi, 2010. 5. *Electronic Devices and Circuits–I & II* by A. P. Godse and U. A. Bakshi, Technical Publications, Pune, 2010. 6. *Solid State Electronic Devices* by B. G. Streetman, PHI Learning Pvt. Ltd., New Delhi. 7. *Electronic Devices and Circuits* by A. Mottershead, PHI Learning Pvt. Ltd., New Delhi. 8. *Solid State Devices and Electronics* by Kamal Singh and S. P. Singh, S. Chand & Co., New Delhi. 9. *Physics for Degree Students: B.Sc. Second Year* by C. L. Arora and P. S. Hemne, S. Chand Publications, New Delhi, Reprint 2015. 10. *Electronic Fundamentals and Applications* by D. Chattopadhyay and P. C. Rakshit, New Age International Publishers, New Delhi.

Model questions for theory external/ internal examination.	
One sentence/ Very short answer questions (1 Mark)	1. Define Hall coefficient. 2. What is barrier potential in PN junction? 3. What is the function of a filter circuit? 4. Define ripple factor. 5. What is SCR?
Short answer questions (3 Marks)	1. Explain the formation of depletion region in PN junction diode. 2. Compare intrinsic and extrinsic semiconductors. 3. Explain the working of bridge rectifier. 4. Describe Zener diode as a voltage regulator. 5. Compare capacitor filter and inductor filter circuits.
Long Answer Questions (6 Marks)	1. Explain the construction and working of SCR with characteristics. 2. Derive the expression for Hall coefficient in semiconductors. 3. Explain the working of half-wave and full-wave rectifiers with waveforms. 4. Design a regulated power supply using Zener diode and explain its operation. 5. Compare LED, photodiode and varactor diode based on construction and applications.

<table>
<tr><th colspan="2">Physics MJ Lab/ Practical 3 – 129214</th></tr>
<tr><th colspan="2">Experiments related to MJ Th3 and MJ Th4</th></tr>
<tr><th>Credits: 02</th><th>Workload (Hrs./Week): 04</th></tr>
<tr><td>Course Objectives:</td><td>1. Understand the working principles and characteristics of semiconductor devices such as diodes, LEDs, photodiodes, Zener diodes, and SCRs.
2. Acquire experimental knowledge of capacitance measurement techniques, capacitor behavior, and bridge methods.
3. Understand the applications of ballistic galvanometer in charge and capacitance measurements.
4. Study electric field distribution through equipotential mapping and understand concepts of electrostatics.
5. Investigate magnetic properties of materials and determine magnetic susceptibility using standard experimental methods.
6. Study magnetic field distribution due to coils, solenoids, and Helmholtz arrangements.
7. Develop experimental skills in handling laboratory instruments, taking measurements, analyzing data, and interpreting results.
8. Apply computational tools such as Scilab for visualization of scalar and vector fields.
9. Enhance scientific temper, analytical thinking, and report-writing skills through laboratory experimentation.</td></tr>
<tr><td>Course Outcomes:</td><td>By the end of this course, students will be able to:
1. Analyze and interpret the characteristics of semiconductor devices including P-N junction diodes, LEDs, photodiodes, Zener diodes, and SCRs.
2. Measure capacitance using different experimental methods such as leakage method, de-Sauty's bridge, repeated charge decay method, and ballistic galvanometer techniques.
3. Determine dielectric constant and study behaviour of capacitors under different configurations.
4. Perform experiments involving ballistic galvanometer and evaluate charge sensitivity accurately.
5. Plot equipotential surfaces and explain electric field distribution for different electrode configurations.
6. Determine magnetic susceptibility of liquids and magnetic materials using Quincke's method and Guoy's balance method.
7. Measure and analyze magnetic fields produced by coils, solenoids, and Helmholtz coil arrangements.
8. Use Scilab to represent gradient, divergence, and curl for scalar and vector fields.</td></tr>
</table>

List of Experiments:
Perform at least eight (8) experiments from the given list. (at least 3 experiments related to each theory paper)
1. Study of Hall effect. 2. To study characteristics of P-N Junction rectifier diode. 3. To study forward characteristics of Light Emitting Diode. 4. To study forward characteristics of Point Contact Diode. 5. To study Photodiode Characteristics. 6. To study reverse characteristics of Zener diode. 7. To study Zener regulated power supply. 8. To study Half Wave and Full Wave/ Full Wave Bridge Rectifier without filter. 9. To study Half Wave and Full Wave/ Full Wave Bridge Rectifier with Capacitor filter. 10. To study characteristics of Silicon controlled rectifier. 11. To study gate firing circuit for SCR. 12. To determine the capacitance of a capacitor by leakage method. 13. To verify laws of capacitances by repeated charge decay method. 14. To determine the capacitance of condenser by de-Sauty's bridge. 15. To study parallel plate capacitor and to find dielectric constant of a given material. 16. To determine charge sensitivity of ballistic galvanometer. 17. To determine capacitance of capacitor by absolute method using ballistic galvanometer. 18. To plot equipotential curves for bar electrode, disc electrode and for ring electrode. 19. To measure magnetic field along the axis of a current-carrying circular coil. 20. To draw the magnetic lines of force due to a bar magnet. 21. To draw the magnetic lines of force due to a solenoid. 22. To study the variation of magnetic field due to Helmholtz coil and single coil carrying current. 23. To represent the gradient of scalar field and divergence and curl of vector field using Scilab.

References:	
	1. *B.Sc. Practical Physics* by Harnam Singh and P. S. Hemne, S. Chand Publishing, New Delhi. 2. *Practical Physics (Electricity, Magnetism, Electronics and Optics)* by Anchal Srivastava and R. K. Shukla, Narosa Publishing House, New Delhi. 3. *Advanced Practical Physics for Students* by B. L. Flint and H. T. Worsnop, Asia Publishing House, New Delhi. 4. *A Textbook of Practical Physics* by Indu Prakash and Ramakrishna, Kitab Mahal Publishers, Allahabad. 5. *Practical Physics* by C. L. Arora, S. Chand Publishing, New Delhi. 6. *Practical Physics* by G. L. Squires, Cambridge University Press (Indian Edition), New Delhi. 7. *Electronic Devices and Circuits* by Sanjeev Gupta, Dhanpat Rai Publications, New Delhi. 8. *Principles of Electronics* by V. K. Mehta and Rohit Mehta, S. Chand Publishing, New Delhi. 9. *Basic Electronics* by B. L. Theraja and A. K. Theraja, S. Chand Publishing, New Delhi. 10. *Electricity and Magnetism* by R. Murugeshan, S. Chand & Co. Ltd., New Delhi. 11. *Electricity and Magnetism* by K. K. Tewari, S. Chand Publishing, New Delhi. 12. *Electronic Devices and Circuits* by A. P. Godse and U. A. Bakshi, Technical Publications, Pune. 13. *Solid State Electronic Devices* by B. G. Streetman and Sanjay Banerjee, Pearson Education India, New Delhi.

	14. *Laboratory Manual of Electronics* by Y. R. Sardesai, New Age International Publishers, New Delhi. 15. https://vlab.amrita.edu/ 16. https://www.vlab.co.in/ 17. http://vlabs.iitb.ac.in/vlab/labsps.html

IKS-Physics Theory – 129215	
Indian Knowledge System (IKS)-Physics	
Credits: 02	**Workload (Hrs./Week): 02**
Course Objectives:	1. To introduce students to the foundational concepts of Indian Knowledge System and their contributions to physical sciences. 2. To explore ancient Indian theories of matter, atomic structure, and energy, and compare them with modern scientific principles. 3. To examine the historical development of mechanics and motion in ancient Indian texts, including early understandings of gravity and forces. 4. To study the astronomical and cosmological models proposed by ancient Indian scholars and their relevance to modern astronomy. 5. To analyze the integration of traditional Indian knowledge with contemporary physics and its influence on modern Indian scientists.
Course Outcomes:	By the end of the course, students will be able to: 1. Explain the key concepts of Indian Knowledge System and their significance in the history of science. 2. Compare Kanada's atomic theory (Anu theory) with Dalton's atomic theory and evaluate their similarities and differences. 3. Describe ancient Indian perspectives on motion (Gati), forces (Bala), and gravity as documented in texts like "Lilavati" and others. 4. Analyze the contributions of Aryabhata, Varahamihira, and other scholars to astronomy and cosmology, including models like the Surya Siddhanta. 5. Evaluate the influence of ancient Indian scientific thought on modern physics and scientists such as C.V. Raman and S.N. Bose. 6. Appreciate the interdisciplinary connections between traditional knowledge systems and contemporary scientific research.

Unit	Contents	Work load Allotted	Weight-age of Marks Allotted	Incorporation of Pedagogies
I	**Introduction to Indian Knowledge System:** Overview of Indian Knowledge System (IKS); Conceptof Science in Ancient India; Historical evolution of physical sciences in India; **Vedic Physics and Philosophy:** Study of the philosophical and metaphysical foundations of Indian physics, Concepts like Prakriti (nature), Purusha (consciousness), and their relevance to physics. Theory of five elements (Pancha Bhuta) and the concept of ether (Akasha), Concepts like sound (Nada), light (Prakasha), and heat (Tejas) in Indian Physics.	7 Hrs.	8 Marks	• Discuss the concepts of science in Vedic scripture and see their educational implications. • Understanding the framework for studying the universe's fundamental nature, including the origins of matter, energy, and the forces that govern them as per the Vedic philosophy. • Encourage comparison between ancient and modern scientific concepts.
II	Matter and Atomic Theories: Kanada's Vaisheshika philosophy: Atomism and Anu theory; Six categories of reality (Padarthas); Comparison with Dalton's atomic theory; Energy and motion according to ancient Indian thought.	7 Hrs.	8 Marks	• Analyze translated verses from Vaisheshika Sutra and explain meaning in modern terms. • Discuss the metaphysical basis of atomic motion in Indian thought.
III	Mechanics and Motion: Ancient concepts of motion (Gati) and forces (Bala); Bhaskaracharya's "Lilavati" and laws of motion; Understanding concepts like gravity in ancient Indian texts; Indian Ancient Instruments for measuring time and studying motion: Sundials, Water Clocks, Dhanu Yantra, Yasti Yantra.	8 Hrs.	8 Marks	• Compare Bhaskara's motion problems with modern kinematic equations. • Solve select Lilavati problems in groups, interpret in SI units. • Enact a dialogue between Bhaskara and Newton discussing gravity and motion.
IV	Astronomy and Cosmology: Aryabhata's and Varahamihira's contributions to Astronomy; Solar system models (Surya Siddhanta); Time measurements: Yuga, Kalpa, and cosmic cycles; Ancient Indian	8 Hrs.	8 Marks	• Create a dual timeline showing developments in Indian astronomy and Western astronomy. • Derive planetary positions using simplified Surya Siddhanta

	observatories (Jantar Mantar) Modern Perspectives and Integration: Bridging traditional knowledge with modern physics; Contributions of modern Indian physicists influenced by ancient knowledge (e.g., C.V. Raman, S.N. Bose)			formulas and compare with modern models. • Field trip/Case studies of instruments at Jantar Mantar; virtual astronomy apps. • Presentations on C.V. Raman, S.N. Bose, etc., focusing on their Indian intellectual heritage. • Debate on cyclic time (Indian) vs. linear time (Western cosmology).

References:	1. *Science and Technology in Ancient India* by Debiprasad Chattopadhyaya, Firma KLM Pvt. Ltd., Kolkata. 2. *Knowledge Traditions and Practices of India* by NCERT, National Council of Educational Research and Training (NCERT), New Delhi. 3. *Foundations of Indian Science* by C. K. Raju, Pearson Education, New Delhi. 4. *Vaisheshika Sutra*, *Aryabhatiya*, and *Surya Siddhanta* (Translated Editions), Motilal Banarsidass Publishers, New Delhi.

Model questions for theory external/ internal examination.	
One sentence/ Very short answer questions (1 Mark)	1. What is the primary goal of Indian Knowledge System (IKS)? 2. Which domain of Indian Knowledge system includes works like the Vedas, Upanishads and the Bhagavad Gita? 3. How Many Vedas are there in Indian Knowledge System? 4. Which ancient Indian text discusses the concept of motion & mechanics?
Short answer questions (3 Marks)	1. What does IKS stand for? What are the main characteristics of IKS? 2. Define Purusha and Prakriti. 3. What is “Vaishesika”? 4. What are Four Vedas? 5. What is the significance of Surya Siddhanta?
Long Answer Questions (6 Marks)	1. What is the concept of "Panchabhuta" in ancient Indian science, and how does it relate to the understanding of the universe? 2. What is “Yuga” concept in Indian Astronomy, and how was it used to measure time and track seasonal changes within the Indian Calendar system? 3. Briefly describe Kanada’s atomic theory. 4. Describe Bhaskara’s concept of gravity, its relevance to the understanding of celestial bodies, and how it predates Newton's law of gravity. 5. Discuss the importance of the six Padarthas in understanding the nature of reality, according to the Vaisesika philosophy.

Physics MN Theory 3 – 129216	
Mathematical Physics and Solid State Devices	
Credits: 02	**Workload (Hrs./Week): 02**
Course Objectives:	1. To provide students with a strong foundation in mathematical tools essential for physics, including scalar and vector fields, gradient, divergence, curl, and integral theorems. 2. To introduce the fundamental concepts of semiconductors, including intrinsic and extrinsic types, carrier concentrations, and Fermi levels. 3. To explain the working principles of PN junctions, rectifiers, and power supplies, along with their applications in electronic devices. 4. To equip students with problem-solving skills through numerical applications in semiconductor physics.
Course Outcomes:	By the end of the course, students will be able to: 1. Apply mathematical concepts such as gradient, divergence, curl, and integral theorems to solve physics problems. 2. Explain the behavior of intrinsic and extrinsic semiconductors, including carrier concentrations and Fermi levels. 3. Describe the operation of PN junctions under different biasing conditions and interpret their characteristics. 4. Compare the performance of half-wave, full-wave, and bridge rectifiers and their applications in power supplies. 5. Demonstrate an understanding of the construction and working principles of Zener diodes, LEDs, and photodiodes. 6. Solve numerical problems related to Mathematical Physics and semiconductor physics.

Unit	Contents	Work-load Allotted	Weight-age of Marks Allotted	Incorporation of Pedagogies
I	**Mathematical Physics:** Scalar and Vector fields, Scalar and Vector product, Gradient and its physical significance, Divergence and its physical significance, Curl and its physical significance, Line integral, Surface integral and Volume integral, Gauss's divergence theorem, Stokes' theorem, Numerical.	8 Hrs.	8 Marks	• Use diagrams, simulations, or animations to illustrate: Scalar and vector fields. • Engage students with interactive simulations about Gradient, Divergence and Curl. • Explain in details about Gauss's divergence theorem, Stokes' theorem.
II	**Semiconductors:** Introduction, intrinsic and extrinsic semiconductors. P-type and N-type extrinsic semiconductor, majority and minority charge carriers, electron and hole concentration in intrinsic semiconductors, Fermi level in intrinsic and extrinsic semiconductors, Hall effect, expression for Hall coefficient, applications of Hall effect.	7 Hrs.	8 Marks	• Use diagrams, simulations, or animations to illustrate Semiconductor concept • Engage students with interactive simulations about Intrinsic and extrinsic semiconductors. • Use diagrams, animations, or simulations to illustrate formation of PN junction.
III	**PN junction:** Formation of PN junction, PN junction with no bias, depletion region, barrier potential, forward bias and reverse bias of PN junction diode and characteristics. **Rectifiers:** Half wave rectifier, full-wave rectifier, bridge rectifier, comparison of rectifiers. **Zener diode:** Zener diode (construction, biasing and characteristics), Numerical.	8 Hrs.	8 Marks	• Use diagrams, animations, or simulations to illustrate formation of PN junction. • Engage students in discussions about Rectifiers and working of different rectifier circuits. • Use animations to illustrate concept and working of different filter circuits and Zener diode. • Conduct experiments or demonstrations to illustrate construction, biasing, characteristics of Zener diode.
IV	**Filter circuits:** Capacitor filter, inductor filter, L-section and π- section filter. **Power Supply:** unregulated power supply, Zener diode as voltage regulator, line and load regulation, regulated power supply.	7 Hrs.	8 Marks	• Explain Capacitor filter, inductor filter, L-section and π- section filter. • Explain Zener diode as voltage regulator. • Explain difference between unregulated and regulated power supply.

References:	
	1. *Mathematical Physics* by Kakani and Hemrajani, CBS Publishers & Distributors, New Delhi. 2. *Mathematical Physics* by B. S. Rajput, Pragati Prakashan, Meerut. 3. *Vector Analysis and Electrostatics* by J. P. Agrawal, Sanjay Singh, and S. A. Waghole, Pragati Prakashan, Meerut. 4. *Elements of Electronics* by M. K. Bagade and S. P. Singh, S. Chand Publications, New Delhi. 5. *Principles of Electronics* by V. K. Mehta, S. Chand Publications, New Delhi. 6. *Electronic Devices and Circuits* by Sanjeev Gupta, Dhanpat Rai Publications, New Delhi, 2010. 7. *Solid State Electronic Devices* by B. G. Streetman, PHI Learning Pvt. Ltd., New Delhi. 8. *Electronic Devices and Circuits* by A. Mottershead, PHI Learning Pvt. Ltd., New Delhi. 9. *Solid State Devices and Electronics* by Kamal Singh and S. P. Singh, S. Chand & Co., New Delhi. 10. *Physics for Degree Students: B.Sc. Second Year* by C. L. Arora and P. S. Hemne, S. Chand Publications, New Delhi, Reprint 2015. 11. *Electronic Fundamentals and Applications* by D. Chattopadhyay and P. C. Rakshit, New Age International Publishers, New Delhi. 12. *Concepts of Modern Physics* by Arthur Beiser, McGraw Hill Education, New Delhi.

Model questions for theory external/ internal examination.	
One sentence/ Very short answer questions (1 Mark)	1. Define curl of a vector field. 2. What is a semiconductor? 3. Define line regulation. 4. What is depletion layer? 5. Name one application of photodiode.
Short answer questions (3 Marks)	1. Explain Gauss's divergence theorem. 2. Differentiate between half-wave and bridge rectifier. 3. Explain majority and minority charge carriers. 4. Explain the working of Zener diode. 5. Compare full-wave rectifier and bridge rectifier.
Long Answer Questions (6 Marks)	1. Derive Stokes' theorem and explain its significance. 2. Explain the formation and characteristics of PN junction diode. 3. Explain the construction and working of π-section filter. 4. Explain how Zener diode can be used in voltage regulation circuits. 5. Discuss Hall effect and its applications in semiconductor physics.

Physics MN Lab/ Practical 3 – 129217	
Experiments related to MN Th3	
Credits: 02	**Workload (Hrs./Week): 04**
Course Objectives:	1. To understand the characteristics and working principles of semiconductor devices such as P-N junction diode, Zener diode, LED, photodiode, and point contact diode. 2. To study and analyze the performance of rectifier circuits and regulated power supplies with different filter configurations. 3. To develop experimental skills in measurement, observation, data recording, and analysis of electronic circuits and semiconductor characteristics. 4. To acquire practical knowledge of Hall effect and its applications in determining semiconductor properties. 5. To apply computational tools such as Scilab for visualization and representation of scalar and vector fields, including gradient, divergence, and curl.
Course Outcomes:	On successful completion of this course, the students will be able to 1. Demonstrate the characteristics and applications of various semiconductor devices and electronic components through laboratory experiments. 2. Analyze the operation and efficiency of half-wave, full-wave, and bridge rectifier circuits with different filter arrangements and regulated power supplies. 3. Perform electronic experiments systematically using appropriate instruments while following laboratory safety and standard procedures. 4. Determine and interpret Hall effect parameters and semiconductor behavior from experimental observations. 5. Use Scilab to represent and interpret scalar and vector field operations such as gradient, divergence, and curl for scientific analysis.

List of Experiments: Perform at least eight (8) experiments from the given list.
1. Study of Hall effect. 2. To study characteristics of P-N Junction rectifier diode. 3. To study forward characteristics of Light Emitting Diode. 4. To study forward characteristics of Point Contact Diode. 5. To study Photodiode Characteristics. 6. To study reverse characteristics of Zener diode 7. To study Zener regulated power supply. 8. To study Half Wave Rectifier without filter. 9. To study Half Wave Rectifier with capacitor filter. 10. To study Full Wave Rectifier without filter. 11. To study Full Wave Rectifier with capacitor filter. 12. To study Full Wave Bridge Rectifier without filter. 13. To study Full Wave Bridge Rectifier with capacitor filter. 14. To study Full Wave Bridge Rectifier with L-section filter. 15. To study Full Wave Bridge Rectifier with π-section filter. 16. To represent the gradient of scalar field and divergence and curl of vector field using Scilab.

References:	1. *Basic Electronics* by B. L. Theraja and A. K. Theraja, S. Chand Publishing, New Delhi. 2. *Principles of Electronics* by V. K. Mehta and Rohit Mehta, S. Chand Publishing, New Delhi. 3. *Electronic Devices and Circuits* by Sanjeev Gupta, Dhanpat Rai Publications, New Delhi. 4. *Electronic Devices and Circuits* by A. P. Godse and U. A. Bakshi, Technical Publications, Pune. 5. *Elements of Electronics* by M. K. Bagade and S. P. Singh, S. Chand Publications, New Delhi. 6. *Solid State Devices and Electronics* by Kamal Singh and S. P. Singh, S. Chand & Co., New Delhi. 7. *Solid State Electronic Devices* by B. G. Streetman and Sanjay Banerjee, Pearson Education India, New Delhi. 8. *Electronic Fundamentals and Applications* by D. Chattopadhyay and P. C. Rakshit, New Age International Publishers, New Delhi. 9. *Laboratory Manual of Electronics* by Y. R. Sardesai, New Age International Publishers, New Delhi. 10. *Practical Physics* by C. L. Arora, S. Chand Publishing, New Delhi. 11. *B.Sc. Practical Physics* by Harnam Singh and P. S. Hemne, S. Chand Publishing, New Delhi. 12. *Vector Analysis and Electrostatics* by J. P. Agrawal, Sanjay Singh, and S. A. Waghole, Pragati Prakashan, Meerut. 13. *Mathematical Physics* by B. S. Rajput, Pragati Prakashan, Meerut. 14. *Scilab: A Practical Introduction* by S. N. Sivanandam and S. Sumathi, McGraw Hill Education (India), New Delhi. 15. https://vlab.amrita.edu/ 16. https://www.vlab.co.in/ 17. http://vlabs.iitb.ac.in/vlab/labsps.html

Physics OE-5 Theory – 129218	
Solar Energy and Its Applications	
Credits: 02	**Workload (Hrs./Week): 02**
Course Objectives:	1. To introduce students to the fundamental concepts of energy, sustainability, and the critical role of renewable energy in addressing environmental challenges. 2. To provide an overview of solar energy, including its principles, advantages, and limitations, without requiring advanced mathematical background. 3. To explore practical solar thermal applications such as water heating, cooking, and space conditioning. 4. To explain the basics of solar photovoltaics, including electricity generation, types of solar panels, and their applications in residential and industrial settings. 5. To examine emerging solar technologies like solar-powered vehicles, solar architecture, and innovative trends such as floating solar plants. 6. To analyze the economic and policy aspects of solar energy, including costs, incentives, and global or regional (e.g., Indian) perspectives.
Course Outcomes:	By the end of the course, students will be able to: 1. Explain the importance of energy sustainability and the environmental benefits of transitioning to renewable sources like solar energy. 2. Describe the basic principles of solar radiation and how it is harnessed for practical applications. 3. Compare different solar thermal technologies (e.g., water heaters, cookers) and their suitability for specific needs. 4. Outline the process of electricity generation using solar photovoltaics and distinguish between types of solar panels. 5. Discuss emerging solar technologies and their potential to revolutionize transportation, architecture, and large-scale energy production. 6. Evaluate the economic viability of solar energy projects and the impact of government policies on adoption. 7. Contextualize solar energy trends within a regional framework (e.g., India's solar mission or global initiatives).

Unit	Contents	Workload Allotted	Weight-age of Marks Allotted	Incorporation of Pedagogies
I	**Introduction to Energy and Sustainability:** Importance of energy in modern life; Environmental issues and climate change; Role of renewable energy; Basics of Solar Energy: What is solar energy? Solar radiation: basics (simple concepts, no equations); Advantages and challenges.	7 Hrs.	8 Marks	• Ask students to create a mind map connecting energy use to different aspects of modern life. • Use short documentaries (e.g., NASA's Climate Change visualizations). • Greenhouse effect using jars, thermometers, and lamps. • Students act as policymakers proposing a clean energy plan for a fictional country.
II	**Solar Thermal Applications:** Solar water heaters; Solar cooking technologies; Solar space heating and cooling.	7 Hrs.	8 Marks	• Use digital tools (like Energy3D or Solar Design Tool) to simulate energy gains/losses in solar-heated buildings. • Discussion on: "Why is solar cooling more relevant for tropical countries like India?" • Simple solar cooker or solar garden light.
III	**Solar Photovoltaics:** Basics of electricity generation using solar cells; Different types of solar panels; Small-scale and large-scale solar applications (home, industry)	8 Hrs.	8 Marks	• Show the step-by-step process of how sunlight is converted into electricity. • Use a mini solar panel to power a fan or LED in real-time sunlight. • Compare a solar cell to a water pump - sunlight acts like pressure that moves electrons (like water). • Group Presentation: Each group presents one type of panel and its merits/drawbacks.
IV	**Emerging Solar Technologies:** Solar-powered vehicles; Solar architecture (buildings designed with solar passive techniques); New trends like floating solar plants. Economics and Policy of Solar Energy: Costs and benefits;	8 Hrs.	8 Marks	• Students sketch their own model of a solar vehicle with key components labeled. • Group Discussion: Benefits and limitations of solar transport in urban vs rural areas.

	Incentives, subsidies, and government policies; Global and Indian context (can localize based on your country)			• Design of buildings to maximize use of sunlight for heating, lighting, and ventilation. • Compare a conventional vs. solar-passive designed building in terms of energy efficiency. • Estimate the cost of installing a 2kW rooftop solar system and calculate payback period.

References:	1. *Solar Photovoltaics: Fundamentals, Technologies and Applications* by Chetan Singh Solanki, PHI Learning Pvt. Ltd., New Delhi. 2. *Energy Technology: Non-Conventional, Renewable and Conventional* by S. Rao and B. B. Parulekar, Khanna Publishers, New Delhi. 3. *Energy Technology: Non-Conventional, Renewable and Conventional* by S. Rao and B. B. Parulekar, Khanna Publishers, New Delhi, 4th Edition. 4. *Non-Conventional Energy Resources* by G. D. Rai, Khanna Publishers, New Delhi. 5. *Solar Energy: Fundamentals and Applications* by H. P. Garg and J. Prakash, Tata McGraw-Hill Education, New Delhi. 6. *Renewable Energy: Engineering and Technology – Principles and Practice* by S. P. Sukhatme and J. K. Nayak, Tata McGraw-Hill Education, New Delhi.

Model questions for theory external/ internal examination.	
One sentence/ Very short answer questions (1 Mark)	1. Define solar constant. 2. What is photovoltaic effect? 3. What is solar passive architecture? 4. Name one application of solar thermal energy. 5. What is floating solar plant?
Short answer questions (3 Marks)	1. Explain the working principle of solar cooker. 2. State advantages of solar water heater. 3. Explain the construction of a solar cell. 4. Differentiate renewable and non-renewable energy sources. 5. Compare solar thermal and solar photovoltaic technologies.
Long Answer Questions (6 Marks)	1. Explain the working principle and applications of photovoltaic cells. 2. Discuss the advantages and limitations of solar energy. 3. Explain solar architecture and its importance in energy conservation. 4. Analyse the role of solar energy in sustainable development in India. 5. Explain government policies and incentives promoting solar energy.

Physics VSC-2 Lab/ Practical – 129219	
Electrical Installation for Residential Buildings	
Credits: 02	**Workload (Hrs./Week): 04**
Course Objectives:	1. Introduce Fundamental Electrical Concepts 2. Develop Proficiency in Electrical Tools and Safety Practices 3. Explain Residential Electrical Components and Systems 4. Teach Electrical Circuit Design and Load Calculation 5. Enable Hands-On Wiring and Installation Skills 6. Impart Troubleshooting and Maintenance Skills 7. Foster Compliance with Standards and Codes 8. Encourage Systematic Project Execution
Course Outcomes:	After completing the course, the student will be able to: 1. Define key electrical terms, list safety rules, and identify basic tools used in residential wiring. 2. Explain working principles of residential circuits and components; interpret wiring diagrams and basic load calculations. 3. Demonstrate proper use of tools and install residential electrical wiring, DBs, switches, sockets, and light fixtures. 4. Diagnose electrical faults in residential systems and suggest corrective actions. Assess electrical installations for adherence to safety codes (like IS/IE rules) and quality workmanship 5. Design, plan, install, and test a fully functional residential electrical wiring project based on a given layout.

Unit	Theoretical Background	Lab/ Practical/ Demonstrations/Activities
I	**Basics of Electricity & Electrical Wiring Systems** • Basic electrical concepts: Voltage, current, resistance, power • AC vs DC, Single-phase vs Three phase • Types of wiring systems (conduit, surface, concealed) • Types of wires and cables • Circuit protection devices (MCBs, RCDs, ELCBs)	1. Identifying and using hand tools: Screwdrivers, testers, pliers, multimeters 2. Using power tools: Drills, conduit benders 3. Safety demo: Proper handling of live wires 4. Wire stripping, jointing, soldering 5. Installing switches, sockets, and light fixtures 6. Color coding and cable management
II	**Circuit Design, Load Calculation & Residential Distribution Boards** • Basic circuit design • Load calculation for appliances and lighting • Understanding and interpreting wiring diagrams • DB components: Busbars, MCBs, Isolators, RCDs • Earthing systems	7. Creating circuit layouts on paper 8. Connecting a basic lighting and power circuit 9. Identifying overload issues in setups 10. Installing and wiring a distribution board 11. Connecting different loads to appropriate breakers 12. Testing for continuity and insulation resistance
III	**Lighting Systems & Earthing** • Types of residential lighting: CFL, LED, Smart lights • Switching systems: 1-way, 2-way, intermediate • Importance of earthing • Types of earthing: Plate, pipe, rod	13. Installing different types of light fixtures 14. Configuring multiple switch types 15. Light dimming and timer-based setups 16. Installing earthing electrodes 17. Testing earth resistance 18. Bonding water pipes and metal parts
IV	**Smart Home Basics** • Introduction to Smart home devices • Smart Switches, Smart Plugs • Wi-Fi enabled bulbs, IR blaster • Alexa / Google Home / Apple Siri integration	19. Install and configure smart switch 20. Connect and configure a Wi-Fi enable bulb 21. Install and configure smart plug 22. Integration of smart switch, smart plug and Wi-Fi bulb with the Alexa / Google Home / Apple Siri App

References:	1. *Basic Electrical Engineering* by V. K. Mehta and Rohit Mehta, S. Chand & Company Pvt. Ltd., New Delhi, 2018. 2. *Electrical Wiring, Estimating and Costing* by Surjit Singh, Dhanpat Rai & Co., New Delhi, 2015. 3. *Installation, Testing and Commissioning of Electrical Installations* by J. B. Gupta, S. K. Kataria & Sons, New Delhi, 2013. 4. *Electrical Wiring, Estimating and Costing* by S. L. Uppal and G. C. Garg, Khanna Publishers, New Delhi, 2016. 5. *Practical Guide to Electrical Wiring* by H. Joshi, McGraw Hill Education (India) Pvt. Ltd., New Delhi, 2014. 6. *A Course in Electrical Power* by J. B. Gupta, S. K. Kataria & Sons, New Delhi, 2013.

Physics FP/CEP-1 Project – 129220	
Field Project / CE Services in Physics: Phase-I	
Credits: 02	**Workload (Hrs./Week): 04**
Course Objectives:	1. To provide hands-on experience in applying theoretical physics knowledge to real-world challenges through field-based projects or community engagement (CE) services. 2. To train students in identifying, analyzing, and solving practical problems encountered in physics-related fieldwork or community service activities. 3. To encourage students to integrate physics concepts with interdisciplinary knowledge, technology, and societal needs. 4. To develop students' abilities to document, present, and communicate their field-based or community engagement work effectively to diverse audiences. 5. To instill a sense of responsibility and service by involving students in projects that address community issues related to science and technology.
Course Outcomes:	1. Students will be able to apply physics principles and analytical techniques to investigate and solve real-world problems in field settings. 2. Students will demonstrate proficiency in using experimental tools, instruments, and data analysis methods relevant to their field project or CE service. 3. Students will be able to design, plan, and execute a field project or community service activity from inception to completion, including documentation and reporting. 4. Students will effectively communicate their project findings and outcomes through written reports, presentations, or community engagement events. 5. Students will demonstrate an understanding of the ethical, environmental, and societal impacts of their work, showing a commitment to responsible scientific practice and community well-being.
• **Guidelines/SOP for Selection and Implementation of Field Projects / CE Services**	
1. Project Selection and Planning	• **Faculty Guidance:** Students will be assigned a faculty mentor to guide their project, providing expertise and resources. • **Project Topic:** The project topic should be relevant to physics and align with the student's interests and the available resources. • **Literature Review:** Students are expected to conduct a thorough literature review to understand existing knowledge and identify research gaps. • **Data Collection and Analysis:** Projects often involve experiments, simulations, or data analysis from existing sources, depending on the topic. • **Project Timeline:** The total time allocation for the student to carry out field project is 60 hours.
2. Data Analysis and Interpretation	• **Statistical Methods:** Students will learn and apply appropriate statistical methods to analyze data. • **Interpretation of Results:** Data should be interpreted within the context of the project, highlighting significant findings and limitations.
3. Report Writing and Presentation	• **Report Format:** A structured report format is usually followed, including an abstract, introduction, methodology, results, discussion, and conclusion.

	• **Data Presentation:** Data should be presented clearly and accurately using tables, graphs, and figures. • **Oral Presentation:** Students will be required to present their findings to peers and faculty.
4. CE Services (Community Engagement)	• **Community Needs:** Projects may focus on addressing specific community needs or challenges relevant to physics. • **Collaboration:** Students can collaborate with local organizations to implement their projects. • **Impact Assessment:** The impact of the project on the community should be evaluated.
5. Evaluation and Assessment	• **Project Report:** The final report will be assessed based on its content, organization, and the quality of the research. **(20 Marks)** • **Oral Presentation:** The presentation will be evaluated on clarity, engagement, and the ability to answer questions. **(10 Marks)** • **Faculty Evaluation:** The faculty mentor will assess the student's performance throughout the project. **(20 Marks)** • **Total 50 Marks**
Examples of Field Projects/CE Services in Physics	• **Environmental Physics:** Studying the impact of pollution on local ecosystems or developing renewable energy solutions. • **Health Physics:** Investigating the effects of radiation on human health or developing medical imaging technologies. • **Education:** Designing physics experiments or teaching physics to younger students. • **Community Outreach:** Organizing science workshops or engaging in scientific literacy initiatives. • **Research Project:** Study related to the subject Physics that contribute to the advancement of knowledge and the well-being of life on Earth.

Note: The extended portion of the Field Project/CE Services in Physics from Phase-I may be carried forward as Field Project/CE Services in Physics: Phase-II in the fourth semester, subject to the approval of the assigned faculty mentor.

The objectives of the project shall be decided phase-wise and a project report must be submitted at the end of every semester.

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI
FACULTY: Science and Technology
Subject: PHYSICS
Teaching and Learning Scheme for the Degree of Bachelor of Science (B.Sc.)
Three Years / Four Years - (Six/Eight Semesters) Bachelor Degree Programme

SECOND YEAR: Level 5.0 - SEMESTER – IV (T & L Credit Scheme)

Mode of Teaching	Vertical No	The Vertical	Type of Course	Course Code	Course Name	Credits	Workload (Hrs/Week)	Vertical Workload (Hrs/Week)
Classroom Teaching/ Lab Work (Practical / Outdoor/ Field/Online/Hybrid)	A	Major	Physics MJ Theory 5	129221	Kinetic Theory of Gases and Thermodynamics	2	2	**10**
			Physics MJ Theory 6	129222	Solid State Devices-II	2	2	
			Physics MJ Theory 7	129223	Optics and Laser	2	2	
			Physics MJ Lab/Practical 4	129224	Experiments related to MJ Th5, Th6 and Th7	2	4	
	B	Minor	Physics MN Theory 4	129225	Transistor, Op-Amp, Fibre Optics and Laser	2	2	**6**
			Physics MN Lab/Practical 4	129226	Experiments related to MN Th4	2	4	
	C	Generic/ Open Elective	Physics OE-6 Theory	129227	Physics in Agriculture	2	2	**2**
	D	VSC	Physics VSC-3 Lab/Practical	129228	Mobile Repairing Technician	2	4	**4**
	E	AEC				2	2	***2***
		IKS (Generic)				-	-	
		VEC				-	-	
	F	FP/CES	Physics FP/CES-2 Project	129229	Field Project / CE Services	2	4	**8**
		CC	Outdoor	-	Separate SOP will be released	2	4	
TOTAL						**22**	**32**	**32**

<table>
<tr><th colspan="2">Physics MJ Theory 5 – 129221</th></tr>
<tr><th colspan="2">Kinetic Theory of Gases and Thermodynamics</th></tr>
<tr><th colspan="2">Credits : 02   Workload (Hrs/Week) : 02</th></tr>
<tr><td>Course Objectives:</td><td>1. To understand the basic concepts and postulates of kinetic theory of gases.
2. To study mean free path, degrees of freedom and equipartition of energy.
3. To understand the behaviour of real gases and Van der Waals equation of state.
4. To introduce the fundamental concepts and laws of thermodynamics.
5. To apply the first law of thermodynamics to various thermodynamic processes.
6. To understand reversible and irreversible processes, Carnot cycle, and heat engines.
7. To study entropy and its relation with the second law of thermodynamics.
8. To understand thermodynamic potentials, Maxwell’s relations and their physical significance.</td></tr>
<tr><td>Course Outcomes:</td><td>At the end of the course, students will be able to:
1. Explain the assumptions and applications of kinetic theory of gases.
2. Analyse Maxwell’s distribution of molecular velocities and calculate most probable, mean, and rms velocities.
3. Apply the concepts of mean free path, degrees of freedom and equipartition of energy to gaseous systems.
4. Explain the behaviour of real gases using Van der Waals equation of state and critical constants.
5. Interpret Andrews’ experiment and distinguish between ideal and real gas behaviour.
6. Describe the basic concepts, terminology and laws of thermodynamics.
7. Apply the first law of thermodynamics to isothermal, adiabatic, isochoric and isobaric processes.
8. Analyse reversible and irreversible processes, Carnot cycle, heat engines and refrigerators.
9. Explain entropy changes and relate entropy with the second law of thermodynamics.
10. Derive and apply thermodynamic potentials, Maxwell’s relations and heat capacity equations to physical systems.</td></tr>
</table>

Unit	Contents	Work-load Allotted	Weight-age of Marks Allotted	Incorporation of Pedagogies
I	**Kinetic theory of gases:** Assumptions; derivation of the pressure of a perfect gas; Maxwell's law of distribution of velocities (qualitative), most probable velocity, mean velocity, and rms velocity. Expression for mean free path, degrees of freedom, and principle of equipartition of energy. Specific heats of an ideal gas and their ratio (mono-, di- and poly-atomic gas); Numerical	7 Hrs	8 Marks	1. Lecture-cum-discussion method 2. Concept-based teaching using kinetic models 3. Interactive classroom questioning 4. ICT-enabled teaching using animations and simulations of gas molecules 5. Tutorial sessions on Maxwell's distribution law and equipartition theorem 6. Assignment-based learning
II	**Real gases:** Derivation of Van der Waals equation of state; derivation of critical constants; Andrews' experiment on carbon dioxide; comparison of Van der Waals isotherms with Andrews' isotherms. **Introduction to thermodynamics:** Basic concepts of thermodynamics; concept of system and surroundings; intensive and extensive properties; concept of mechanical, chemical, and thermal equilibrium; Zeroth law of thermodynamics and its significance; concept of heat and temperature; Numerical	8 Hrs	8 Marks	1. Lecture method with graphical explanation of isotherms 2. Demonstration using P–V diagrams and thermodynamic charts 3. ICT-enabled teaching through simulations and multimedia presentations 4. Student seminars on applications of thermodynamics
III	**First and Second Law of Thermodynamics:** First law of thermodynamics and its significance. Equation of state. Work done in isothermal and adiabatic processes for a perfect gas. Internal energy as a state function; application of first law to cyclic, isothermal, adiabatic, isochoric, and isobaric processes.	8 Hrs	8 Marks	1. Lecture and interactive teaching 2. Derivation-based teaching for thermodynamic processes 3. Problem-solving sessions on work, heat, and efficiency calculations 4. Use of flowcharts and thermodynamic cycle diagrams 5. Case-study approach for heat engines and refrigerators

	Reversible and irreversible processes; second law of thermodynamics (Kelvin's and Clausius statements); Carnot engine, Carnot cycle, and its efficiency (derivation); Carnot theorem (proof); Numerical			6. Question–answer and conceptual discussion sessions
IV	**Entropy and Thermodynamic Potentials:** Basic concept of entropy; change in entropy in reversible and irreversible processes; entropy and disorder; entropy and second law of thermodynamics. Thermodynamic potentials: Basic concepts of internal energy, enthalpy, Helmholtz free energy, Gibbs free energy and their significance; derivation of Maxwell's thermodynamic relations using thermodynamic potentials; heat capacity equations; Numerical	7 Hrs	8 Marks	1. Lecture-cum-discussion method 2. Conceptual teaching using entropy and energy flow diagrams 3. Numerical and analytical problem-solving sessions 4. ICT-enabled teaching using simulations and visual presentations 5. Student-centred learning through assignments and presentations 6. Tutorial sessions for thermodynamic potentials and heat capacity equations

References:	1. *Heat and Thermodynamics*, by Brijlal and N. Subrahmanyam, S. Chand Publishing, New Delhi. 2. *Heat and Thermodynamics*, by D. S. Mathur, S. Chand Publishing, New Delhi. 3. *Heat and Thermodynamics*, by M. W. Zemansky and R. H. Dittman, Tata McGraw-Hill Education, New Delhi (Indian Edition). 4. *Engineering Thermodynamics*, by P. K. Nag, Tata McGraw-Hill Education, New Delhi. 5. *Thermodynamics and Statistical Physics*, by K. K. Tewari, S. Chand Publishing, New Delhi. 6. *Thermal Physics*, by R. Murugeshan and Kiruthiga Sivaprasath, S. Chand Publishing, New Delhi. 7. *Heat, Thermodynamics and Statistical Physics*, by Satya Prakash and J. P. Agarwal, Pragati Prakashan, Meerut. 8. *Heat and Thermodynamics*, by J. B. Rajam and C. L. Arora, S. Chand Publishing, New Delhi. 9. *Thermodynamics and Statistical Mechanics*, by S. C. Gupta and V. Kumar, Pragati Prakashan, Meerut. 10. *Thermodynamics and Statistical Physics*, by P. S. Hemne, Tata McGraw-Hill Education, New Delhi.

	11. *A Text Book of First Year Physics*, by M. K. Bagde and S. P. Singh, S. Chand Publications, New Delhi.

Model questions for theory external/ internal examination.	
One sentence/ Very short answer questions (1 Mark)	1. Define mean free path. 2. State the principle of equipartition of energy. 3. What is Van der Waals equation of state? 4. Define entropy. 5. State the Zeroth law of thermodynamics.
Short answer Questions (3 Marks)	1. Explain the physical significance of rms velocity. 2. Differentiate between ideal gas and real gas. 3. Derive the relation between C_p and C_v for an ideal gas. 4. Explain reversible and irreversible thermodynamic processes with examples. 5. Discuss the importance of thermodynamic potentials in physical systems.
Long Answer Questions (6 Marks)	1. Derive the expression for pressure of a perfect gas on the basis of kinetic theory of gases. 2. Derive Van der Waals equation of state for real gases and explain the significance of its constants. 3. State and explain the first law of thermodynamics. Derive the expression for work done in an adiabatic process. 4. Describe Carnot cycle and derive the expression for efficiency of Carnot engine. 5. Derive Maxwell's thermodynamic relations using thermodynamic potentials and explain their physical significance.

<table>
<tr><th colspan="2">Physics MJ Theory 6 – 129222</th></tr>
<tr><th colspan="2">Solid State Devices-II</th></tr>
<tr><th>Credits: 02</th><th>Workload (Hrs./Week): 02</th></tr>
<tr><td>Course Objectives:</td><td>1. To introduce the fundamental principles of Bipolar Junction Transistors (BJTs), including their construction, working, configurations, and characteristics.
2. To analyze transistor biasing techniques, stability factors, and the operation of different amplifier classes (A, B, AB and C).
3. To study Field Effect Transistors (FETs), including JFETs and MOSFETs, their construction, working principles, characteristics, and differences from BJTs.
4. To understand the basics of Operational Amplifiers (Op-Amps), their ideal characteristics, key parameters, and applications in analog circuits.
5. To develop problem-solving skills through numerical analysis of transistor and FET parameters.
6. To explore practical applications of transistors and Op-Amps in amplifier circuits, signal processing, and other electronic systems.</td></tr>
<tr><td>Course Outcomes:</td><td>By the end of the course, students will be able to:
1. Explain the construction, working of CB and CE configurations of BJT and interpret their characteristics.
2. Analyze transistor biasing circuits, stability factors, and the significance of the operating point in amplifier design.
3. Compare the performance of different amplifier classes (A, B, AB and C) and their applications.
4. Describe the working principles of JFETs and MOSFETs, their characteristics, and key differences from BJTs.
5. Interpret the ideal characteristics and parameters of Op-Amps.
6. Design basic Op-Amp circuits (inverting/non-inverting amplifiers, adders, subtractors, differentiators, and integrators).
7. Solve numerical problems related to transistor biasing, FET parameters, and Op-Amp configurations.
8. Evaluate the role of transistors and Op-Amps in modern electronic devices and signal-processing applications.</td></tr>
</table>

Unit	Contents	Work-load Allotted	Weight-age of Marks Allotted	Incorporation of Pedagogies
I	**Bipolar Junction Transistor:** Types of transistors, construction and working of PNP and NPN transistor, Transistor configuration (CB, CE and CC) modes, characteristics of transistor in CB and CE mode, current gain α and β, relation between α and β, analysis of transistor: dc load line, operating point, active region, cut-off region and saturation region.	8 Hrs.	8 Marks	• Use diagrams, simulations, or animations to illustrate transistor and their types. • Provide step-by-step information of different configurations of transistor to reinforce understanding. • Engage students with interactive simulations or experiments showcasing characteristics of transistor.
II	**Transistors Biasing:** Stability factor, Thermal runaway, Voltage divider bias CE amplifier. Hybrid parameters, low frequency hybrid equivalent circuit of CE amplifier and its analysis, Input impedance, Output impedance, Current gain, Voltage gain and Power Gain, Classification of Amplifier: class A, class B, class AB and class C amplifiers.	8 Hrs.	8 Marks	• Use diagrams, animations, or simulations to illustrate the concept of thermal runaway and biasing stability of CE transistor Amplifier. • Use diagrams and analyze the various parameters of CE Amplifier. • Engage students in discussions towards the practical approach of amplifier classifications.
III	**Field Effect Transistor (FET):** Types of JFET, construction and working of JFET, Characteristics of JFET, parameters of JFET and their relation, difference between JFET and BJT, **MOSFET:** Construction. Working and Characteristics of N-channel depletion and enhancement type MOSFET. Numerical.	7 Hrs.	8 Marks	• Use animations or diagrams to illustrate field effect transistor. • Engage students to identify and differentiate the BJT, FET and MOSFET. • Conduct experiments to understand the construction and working of JFET.
IV	**Operational Amplifier:** Difference Amplifier, Block diagram of Op-Amp, Characteristics of an Ideal Op-Amp, Op-Amp IC 741 (pin diagram), Input bias current, Input offset current, Input offset voltage, Open-loop and Closed-loop Gain, Slew rate,	7 Hrs.	8 Marks	• Use animations or diagrams to illustrate Operational Amplifier. • Engage students in to identify Pins Op-Amp IC-741and their role in electronic circuit. • Conduct experiments using Op-Amp to study the related

	CMRR, concept of Virtual ground. Applications of Op-Amp: Inverting Amplifier, Non-inverting Amplifier, Adder, Subtractor, Differentiator and Integrator.			applications.

References:	1. *Basic Electronics: Solid State* by B. L. Theraja, S. Chand Publications, New Delhi, 2006. 2. *Electronic Principles* by Albert Malvino and David J. Bates, McGraw Hill Education, 7th Edition, 2017. 3. *Principles of Electronics* by V. K. Mehta and Rohit Mehta, S. Chand Publications, New Delhi, 2022. 4. *Op-Amps and Linear Integrated Circuits* by Ramakant A. Gaikwad, PHI Learning Pvt. Ltd., New Delhi, 4th Edition. 5. *Digital and Analogue Techniques* by Navneet Kale and Gokhale, Kitab Mahal Publishers, New Delhi. 6. *Electronics Fundamentals* by David M. Buchla and Thomas L. Floyd, Pearson Education, 8th Edition.

Model questions for theory external/ internal examination.	
One sentence/ Very short answer questions (1 Mark)	1. Define transistor biasing. 2. What is thermal runaway? 3. Define slew rate of Op-Amp. 4. What is MOSFET? 5. Expand CMRR.
Short answer questions (3 Marks)	1. Explain CE configuration of transistor. 2. Differentiate between JFET and MOSFET. 3. Explain virtual ground concept in Op-Amp. 4. Describe class A amplifier. 5. Compare CB and CE transistor configurations.
Long Answer Questions (6 Marks)	1. Explain voltage divider bias method and stability factor. 2. Describe construction and characteristics of JFET. 3. Explain applications of Op-Amp as integrator and differentiator. 4. Design an inverting amplifier using Op-Amp and derive voltage gain expression. 5. Compare transistor amplifiers and FET amplifiers based on performance and applications.

Physics MJ Theory 7 – 129223	
Optics and Laser	
Credits: 02	**Workload (Hrs./Week): 02**
Course Objectives:	1. To introduce the fundamental principles of wave optics, including interference, diffraction, and polarization, and their significance in understanding light behavior. 2. To analyze interference phenomena in thin films, Newton's rings, and Michelson interferometer, including numerical problem-solving. 3. To study diffraction patterns (Fresnel and Fraunhofer) and their applications in determining light wavelength using single/double slits and diffraction gratings. 4. To explain the concept of polarization, its production methods (e.g., Nicol prism, retardation plates), and its role in creating elliptically/circularly polarized light. 5. To explore the principles of lasers, including stimulated emission, population inversion, and the working of Ruby, He-Ne, and semiconductor lasers. 6. To highlight practical applications of optical phenomena and lasers in medical, industrial, agricultural, and research fields.
Course Outcomes:	By the end of the course, students will be able to: 1. Describe the conditions for interference and apply the superposition principle to analyze thin-film interference and Newton's rings. 2. Solve numerical problems related to wavelength determination using interference (Michelson interferometer) and diffraction (grating) techniques. 3. Distinguish between Fresnel and Fraunhofer diffraction and interpret diffraction patterns from single/double slits. 4. Explain polarization mechanisms (e.g., double refraction, quarter/half-wave plates) and demonstrate how to produce polarized light. 5. Illustrate the working principles of lasers, including population inversion and pumping processes in 3-level/4-level systems. 6. Compare the construction and operation of Ruby, He-Ne, and semiconductor lasers. 7. Discuss real-world applications of lasers and polarized light across diverse fields (e.g., medical surgery, optical communications).

Unit	Contents	Work-load Allotted	Weight-age of Marks Allotted	Incorporation of Pedagogies
I	**Interference:** Introduction, principle of superposition of waves, conditions for steady interference, Interference in thin film due to reflected and transmitted light, Newton's rings (formation, theory and application for determination of wavelength), Michelson Interferometer (principle, construction and working), Numerical.	7 Hrs.	8 Marks	• Encourage students to explore and discover interference phenomena through guided experiments or simulations. • Use visual aids, physical models, and hands-on demonstrations to illustrate interference patterns. • Integrate simulations, animations and digital tools.
II	**Diffraction:** Rectilinear propagation of light, Fresnel and Fraunhoffer diffraction, Fraunhoffer diffraction due to single slit, Fraunhoffer diffraction due to double slit, theory of plane transmission grating, determination of wavelength of light by diffraction grating, Numerical.	8 Hrs.	8 Marks	• Use physical demonstrations and models to help students visualize wave behavior. • Use simulations and virtual labs to understand diffraction phenomenon.
III	**Polarization:** Concept of polarization, optic axis, double refraction, polarization by double refraction, phase retardation plate: Quarter wave plate, half wave plate, Nicol prism, production and analysis of polarized light, Theory of production of elliptically and circularly polarized light.	7 Hrs.	8 Marks	• Use models and demonstrations to make polarization more intuitive. • Use Interactive simulations and digital tools to visualize polarized light.
IV	**Laser:** Introduction to Laser, Characteristics of laser, Absorption, Spontaneous and stimulated emission, population inversion, pumping process, Main components of laser system, three level and four level laser system. Construction and working of Ruby laser, He-Ne laser, Semiconductor laser, Applications of laser (Medical, Industrial, Agriculture and Research).	8 Hrs.	8 Marks	• Utilize simulations and digital animations to explain complex laser mechanisms. • Use short conceptual quizzes and diagnostics to clarify understanding.

References:	1. *A text book of Optics*, N. Subrahmanyam, Brijlal, M. N Avadhanulu, S. Chand Publication. 2. *Physics for degree students (B.Sc.1st year)*, C. L. Arora and P.S. Hemne, S. Chand Publication. 3. *Fundamentals of Optics*, Devraj Singh, PHI Learning Pvt. Ltd. 4. *Optics* by Ajoy Ghatak, McGraw Hill Education (India) Private Limited. 5. *Optics* by N. B. L. Mathur, Anmol Publications Pvt. Ltd. 6. *Optics and Spectroscopy*, P. K. Mittal, S. Chand & Company. 7. *Lasers, Theory and Application*, Thyagrajan and Ajay Ghatak, Macmillan India Ltd. 8. *Laser and Nonlinear Optics*, B. B. Laud (2nd Ed.), New Age International.

Model questions for theory external/ internal examination.	
One sentence/ Very short answer questions (1 Mark)	1. Define interference of light. 2. What is diffraction? 3. Define resolving power. 4. What is LASER? 5. Expand the term LASER.
Short answer questions (3 Marks)	1. Explain the conditions for sustained interference. 2. Distinguish between Fresnel and Fraunhofer diffraction. 3. Explain the construction and working of He-Ne laser. 4. Define numerical aperture of optical fibre. 5. Compare interference and diffraction phenomena.
Long Answer Questions (6 Marks)	1. Explain Young's double slit experiment and derive expression for fringe width. 2. Describe diffraction due to a single slit and obtain intensity distribution. 3. Explain the principle, construction and working of He-Ne laser. 4. Explain applications of lasers in communication and medicine. 5. Compare spontaneous emission and stimulated emission.

<table>
<tr><th colspan="2">Physics MJ Lab/ Practical 4 – 129224</th></tr>
<tr><th colspan="2">Experiments related to MJ Th5, Th6 and Th7</th></tr>
<tr><th>Credits: 02</th><th>Workload (Hrs./Week): 04</th></tr>
<tr><td>Course Objectives:</td><td>1. To understand the principles of thermodynamics, heat transfer, electronics, optics, polarization, and laser physics through practical experiments.
2. To develop experimental skills in studying semiconductor devices, transistor amplifiers, FETs, MOSFETs, and operational amplifiers.
3. To verify important physical laws related to gases, heat, optics, and polarization using standard laboratory techniques.
4. To gain practical knowledge of optical instruments and methods used for determining wavelength, refractive index, resolving power, and focal length.
5. To enhance analytical ability, experimental techniques, data interpretation, and scientific report-writing skills.</td></tr>
<tr><td>Course Outcomes:</td><td>On successful completion of this Practical course, the students would be able to:
1. Perform experiments related to heat transfer, gas laws, and thermodynamic properties and analyze the obtained results.
2. Analyze characteristics and applications of transistors, FETs, MOSFETs, and operational amplifier circuits.
3. Determine optical parameters such as wavelength, refractive index, resolving power, and specific rotation using standard optical techniques.
4. Verify laws related to polarization, diffraction, interference, and laser optics experimentally.
5. Demonstrate proficiency in handling laboratory instruments, recording observations, analyzing data, and presenting scientific results effectively.</td></tr>
</table>

List of Experiments: Perform minimum eight (8) experiments from the given list. (at least 2 experiments related to each theory paper)
1. To determine the coefficient of thermal conductivity of a bad conductor by Lee's disc method. 2. To determine the mechanical equivalent of heat by Joule's calorimeter experiment. 3. To determine the mechanical equivalent of heat by Calender and Barne' method. 4. To determine the ratio of specific heats ($\gamma = Cp/Cv$) of air by Clement and Desormes method. 5. To determine the ratio of specific heats of a gas using Kundt's tube method. 6. To verify Charles' law for gases. 7. To verify Boyle's law for gases. 8. To study heat transfer by radiation and Newton's law of cooling. 9. To determine the efficiency of electrical kettle. 10. To determine characteristics of transistor in CB mode. 11. To determine characteristics of transistor in CE mode. 12. To study variation of gain of CE transistor amplifier with load. 13. To study gain frequency response of CE transistor Amplifier. 14. To determine characteristics of FET. 15. To Study transfer and output characteristics of an N- channel MOSFET. 16. To study FET as a voltmeter. 17. Study of OP AMP as an inverting amplifier. 18. Study of OP AMP as non-inverting amplifier. 19. Study of OP AMP as an adder. 20. Study of OP AMP as subtractor. 21. Study of OP AMP as differentiator. 22. Study of OP AMP as an integrator. 23. To determine the Refractive Index of the Material of a given Prism using Sodium Light. 24. To determine wavelength of Sodium light using Newton's Rings. 25. To determine wavelength of Sodium light using plane diffraction Grating. 26. To determine the Resolving Power of a Plane Diffraction Grating. 27. To find the number of lines per centimeter of the given diffraction grating. 28. To determine the wavelength of laser light by plane diffraction grating. 29. To determine the resolving power of telescope. 30. To verify Malu's law. 31. To verify Brewster's law. 32. To determine the refractive indices for ordinary and extra-ordinary rays using double image prism. 33. Study of elliptically polarized light using photodetector. 34. To determine specific rotation of sugar solution by half shade polarimeter. 35. To study the divergence of a LASER beam. 36. To determine the focal length of a given convex lens using LASER.

References:	1. *B.Sc. Practical Physics* by Harnam Singh and P. S. Hemne, S. Chand Publishing, New Delhi. 2. *Practical Physics* by C. L. Arora, S. Chand Publishing, New Delhi. 3. *Heat and Thermodynamics* by Brij Lal and N. Subrahmanyam, S. Chand Publications, New Delhi. 4. *Heat and Thermodynamics* by D. S. Mathur, S. Chand Publications, New Delhi.

	5. *A Textbook of Heat* by J. B. Rajam and C. L. Arora, S. Chand Publications, New Delhi. 6. *Basic Electronics: Solid State* by B. L. Theraja, S. Chand Publications, New Delhi. 7. *Principles of Electronics* by V. K. Mehta and Rohit Mehta, S. Chand Publications, New Delhi. 8. *Electronic Devices and Circuits* by Sanjeev Gupta, Dhanpat Rai Publications, New Delhi. 9. *Op-Amps and Linear Integrated Circuits* by Ramakant A. Gaikwad, PHI Learning Pvt. Ltd., New Delhi. 10. *Electronic Devices and Circuits* by A. P. Godse and U. A. Bakshi, Technical Publications, Pune. 11. *A Textbook of Optics* by N. Subrahmanyam, Brij Lal, and M. N. Avadhanulu, S. Chand Publications, New Delhi. 12. *Optics* by Ajoy Ghatak, McGraw Hill Education (India) Pvt. Ltd., New Delhi. 13. *Fundamentals of Optics* by Devraj Singh, PHI Learning Pvt. Ltd., New Delhi. 14. *Optics and Spectroscopy* by P. K. Mittal, S. Chand & Company Pvt. Ltd., New Delhi. 15. *Lasers: Theory and Applications* by Thyagarajan and Ajoy Ghatak, Macmillan India Ltd., New Delhi. 16. *Laser and Nonlinear Optics* by B. B. Laud, New Age International Publishers, New Delhi, 2nd Edition. 17. *Engineering Physics Laboratory Manual* by S. Panigrahi and B. Mallick, Cengage Learning India Pvt. Ltd., New Delhi. 18. https://vlab.amrita.edu/ 19. https://www.vlab.co.in/

Physics MN Theory 4 – 129225	
Transistor, Op-Amp, Fibre Optics and Laser	
Credits: 02	**Workload (Hrs./Week): 02**
Course Objectives:	1. To provide a comprehensive understanding of Bipolar Junction Transistors (BJTs), including their construction, working principles, configurations (CB, CE, CC), and characteristics. 2. To analyze transistor biasing techniques, stability factors, and the performance of CE amplifiers, including hybrid parameters and gain calculations. 3. To introduce the fundamentals of fibre optics, including light propagation, acceptance angle, numerical aperture, and their applications in communication systems. 4. To study the principles of lasers, including stimulated emission, population inversion, and the working of Ruby and He-Ne lasers, along with their practical applications. 5. To develop problem-solving skills through numerical analysis of transistor parameters and fibre optic properties.
Course Outcomes:	By the end of the course, students will be able to: 1. Explain the construction, working, and configurations of PNP and NPN transistors, and interpret their characteristics in CB and CE modes. 2. Analyze transistor biasing circuits, stability factors, and the DC load line to determine the operating point in different regions (active, cut-off, saturation). 3. Evaluate the performance of CE amplifiers by calculating input/output impedance, current gain, voltage gain, and power gain using hybrid parameters. 4. Describe the principles of fibre optics, including total internal reflection, light propagation, and the significance of acceptance angle and numerical aperture. 5. Compare the advantages and disadvantages of optical fibres and their applications in communication systems. 6. Illustrate the working of lasers, including population inversion and pumping processes in three-level and four-level systems. 7. Discuss the applications of Ruby and He-Ne lasers in medical, industrial, agricultural, and research fields. 8. Solve numerical problems related to transistor biasing, fibre optics, and laser parameters.

Unit	Contents	Workload Allotted	Weightage of Marks Allotted	Incorporation of Pedagogies
I	**Bipolar Junction Transistor:** Types of transistors, construction and working of PNP and NPN transistor, Transistor configuration (CB, CE and CC) modes, characteristics of transistor in CB and CE mode, current gain α and β, relation between α and β., Analysis of transistor dc load line, operating point, active region, cut-off region and saturation region.	8 Hrs.	8 Marks	• Use diagrams, simulations, or animations to illustrate transistor and their types. • Provide step-by-step information of different configurations of transistor to reinforce understanding. • Engage students with interactive simulations or experiments showcasing characteristics of transistor.
II	**Transistors Biasing:** Stability factor, Thermal runaway, base bias and emitter bias CE amplifier. **Op-Amp:** Block diagram of Op-Amp, Characteristics of an Ideal Op-Amp, Op-Amp IC 741 (pin diagram), Input bias current, Input offset current, Input offset voltage, Open-loop & Closed-loop Gain, Slew rate, CMRR, concept of Virtual ground. Applications of Op-Amp: Inverting Amplifier, Non-inverting Amplifier, Adder, Subtractor.	7 Hrs.	8 Marks	• Use diagrams, animations, or simulations to illustrate the concept of thermal runaway and biasing stability of CE transistor Amplifier. • Use animations or diagrams to illustrate Operational Amplifier. • Engage students in to identify Pins OP-Amp IC-741and their role in electronic circuit. • Conduct experiments using OP-Amp to study the related applications.
III	**Fibre optics:** Introduction to fibre optics, total internal reflection, structure and classification of optical fibre. Propagation of light wave in an optical fibre, Acceptance angle and numerical aperture, fibre optic communication. Advantages and Disadvantages of optical fibres, applications of fibre optics.	7 Hrs.	8 Marks	• Use animations and simulations to show light rays propagating through fibre cores and how dispersion occurs. • Use hands-on experiments such as measuring the numerical aperture or visualizing light transmission through plastic fibres.
IV	**Laser:** Introduction to Laser, Characteristics of laser, Absorption, Spontaneous and stimulated emission, population inversion, pumping process, Main components of laser system, three level and four level laser system. Ruby laser, He-	8 Hrs.	8 Marks	• Utilize simulations and digital animations to explain complex laser mechanisms. • Use short conceptual quizzes and diagnostics to clarify understanding.

	Ne laser, Applications of laser (Medical, Industrial, Agriculture and Research).			

References:	1. *Basic Electronics: Solid State* by B. L. Theraja, S. Chand Publications, New Delhi, 2006. 2. *Electronic Principles* by Albert Malvino and David J. Bates, McGraw Hill Education, 7th Edition, 2017. 3. *Principles of Electronics* by V. K. Mehta and Rohit Mehta, S. Chand Publications, New Delhi, 2022. 4. *Electronics Fundamentals* by David M. Buchla and Thomas L. Floyd, Pearson Education, 8th Edition. 5. *Fundamentals of Optical Fibre Communication* by M. Sathish Kumar, PHI Learning Pvt. Ltd., New Delhi. 6. *Textbook on Optical Fibre Communication and Its Applications* by S. C. Gupta, PHI Learning Pvt. Ltd., New Delhi. 7. *Lasers: Theory and Applications* by Thyagarajan and Ajoy Ghatak, Macmillan India Ltd., New Delhi. 8. *Laser and Nonlinear Optics* by B. B. Laud, New Age International Publishers, New Delhi, 2nd Edition.

Model questions for theory external/ internal examination.	
One sentence/ Very short answer questions (1 Mark)	1. Define transistor current gain. 2. What is optical fibre? 3. Define population inversion. 4. What is Op-Amp? 5. What is acceptance angle?
Short answer questions (3 Marks)	1. Explain CE transistor configuration. 2. Describe the characteristics of an ideal Op-Amp. 3. Explain total internal reflection in optical fibre. 4. Explain spontaneous and stimulated emission. 5. Compare step-index and graded-index fibres.
Long Answer Questions (6 Marks)	1. Explain the working of transistor as an amplifier. 2. Describe the applications of Op-Amp as adder and subtractor. 3. Explain construction and working of optical fibre. 4. Explain principle, construction and working of laser. 5. Compare transistor and Op-Amp amplifiers with suitable applications.

Physics MN Lab/ Practical 4 – 129226	
Experiments related to MN Th4	
Credits: 02	**Workload (Hrs./Week): 04**
Course Objectives:	1. To understand the characteristics and applications of transistors and operational amplifiers through practical experiments. 2. To study amplifier gain, frequency response, and signal processing using electronic circuits. 3. To understand the principles and applications of LASER and diffraction techniques in measurements. 4. To gain practical knowledge of optical instruments and fibre optics through experimental investigations. 5. To develop experimental skills, data analysis ability, and scientific reporting techniques in electronics and photonics experiments.
Course Outcomes:	On successful completion of this Practical course, the students would be able to: 1. Analyze the characteristics and performance of transistors in CB and CE configurations and study amplifier behaviour. 2. Construct and study OP-AMP based circuits such as inverting amplifier, non-inverting amplifier, adder, and subtractor. 3. Determine wavelength of LASER light, grating parameters, and thickness of thin wire using diffraction techniques. 4. Study LASER beam divergence, determine focal length of lenses, and evaluate numerical aperture of optical fibre. 5. Demonstrate proficiency in handling electronic and optical instruments, interpreting experimental data, and presenting scientific observations effectively.

List of Experiments: Perform at least eight (8) experiments from the given list.
1. To determine characteristics of transistor in CB mode. 2. To determine characteristics of transistor in CE mode. 3. To study variation of gain of CE transistor amplifier with load. 4. To study gain frequency response of CE transistor Amplifier. 5. Study of OP AMP as an inverting amplifier. 6. Study of OP AMP as non-inverting amplifier. 7. Study of OP AMP as an adder. 8. Study of OP AMP as subtractor. 9. Study of OP AMP as an integrator. 10. Study of OP AMP as differentiator. 11. To determine the wavelength of LASER light by plane diffraction grating. 12. To study the divergence of a LASER beam. 13. To determine the thickness of thin wire using Laser beam 14. To determine the focal length of a given convex lens using LASER. 15. To determine Numerical Aperture of Fibre Optic Cable.

References:	1. *Basic Electronics: Solid State* by B. L. Theraja, S. Chand Publications, New Delhi, 2006. 2. *Electronic Principles* by Albert Malvino and David J. Bates, McGraw Hill Education, 7th Edition, 2017. 3. *Principles of Electronics* by V. K. Mehta and Rohit Mehta, S. Chand Publications, New Delhi, 2022. 4. *Op-Amps and Linear Integrated Circuits* by Ramakant A. Gaikwad, PHI Learning Pvt. Ltd., New Delhi, 4th Edition. 5. *Digital and Analogue Techniques* by Navneet Kale and Gokhale, Kitab Mahal Publishers, New Delhi. 6. *Electronics Fundamentals* by David M. Buchla and Thomas L. Floyd, Pearson Education, 8th Edition. 7. *A Textbook of Practical Physics* by S. L. Gupta and V. Kumar, Pragati Prakashan, Meerut. 8. *Practical Physics* by R. K. Shukla and Anchal Srivastava, New Age International Publishers, New Delhi. 9. *Practical Physics* by Brij Lal and N. Subrahmanyam, S. Chand & Co. Ltd., New Delhi. 10. *Experimental Physics, Vol. 1* by C. L. Arora, S. Chand & Co. Ltd., New Delhi. 11. https://vlab.amrita.edu/ 12. https://www.vlab.co.in/ 13. https://vlabs.iitb.ac.in/vlab/labsps.html

Physics OE-6 Theory – 129227	
Physics in Agriculture	
Credits: 02	**Workload (Hrs./Week): 02**
Course Objectives:	1. To understand the role of natural forces such as gravity, wind, water, sunlight, seasons, and weather in agricultural practices and crop production. 2. To explain the importance of water management, soil properties, capillary action, rainwater harvesting, and traditional water storage methods in sustainable farming. 3. To study the applications of light, heat, greenhouses, crop drying, cold storage, and food preservation techniques in agriculture. 4. To develop awareness about renewable energy sources such as solar energy, wind energy, and biogas and their applications in agricultural activities. 5. To familiarize students with sustainable agricultural practices, local success stories, government incentives, subsidies, and policies related to agriculture and energy conservation.
Course Outcomes:	By the end of this course, students will be able to: 1. Explain the influence of natural forces, seasonal variations, and climatic conditions on farming and crop growth. 2. Apply knowledge of soil characteristics, water movement, rainwater harvesting, and water conservation methods in agricultural contexts. 3. Demonstrate understanding of greenhouse technology, solar drying methods, cold storage systems, and food preservation techniques. 4. Identify and evaluate the use of renewable energy resources and energy-efficient practices in agriculture for sustainable development. 5. Analyze sustainable farming practices and interpret the role of government schemes, incentives, and policies in promoting modern and eco-friendly agriculture.

Unit	Contents	Workload Allotted	Weightage of Marks Allotted	Incorporation of Pedagogies
I	**Agriculture and Natural Forces:** How gravity, wind, water, and sunlight shape farming. Seasons and weather: their impact on crops. Role of sunlight and shade in plant growth.	7 Hrs.	8 Marks	• Demonstration: Soil erosion models using trays and water flow. • Seasonal Calendar: Students prepare crop-weather suitability charts.
II	**Water and Soil:** The Essentials; How water moves in soil (capillary action in simple terms). Rainwater harvesting, traditional water storage. Importance of soil texture and slope in farming.	8 Hrs.	8 Marks	• Observation Activity: Compare plant growth in sun and shade over a week. • Interactive Experiment: Use light filters to study growth under different light conditions. • Lab Demo: Capillary action using glass tubes and water in different soil types. • Soil Texture Feel Test: Sand, loam, and clay analysis by hand.
III	**Light, Heat, and Storage:** Greenhouses and controlled environments. Drying crops using sunlight – traditional and modern methods. Cold storage basics and food preservation.	8 Hrs.	8 Marks	• Mini Greenhouse Build: Create a bottle greenhouse. • Compare Methods: Traditional vs. modern drying – moisture content, time. • Guest Talk: Invite a farmer or agri-entrepreneur to discuss storage innovations.
IV	**Energy and Sustainability in Agriculture:** Use of solar energy, wind energy, and biogas in farms. Energy saving in farming activities. Sustainable practices and local success stories. Incentives, subsidies, and government policies	7 Hrs.	8 Marks	• Planning a sustainable village farm using renewable energy. • Discuss on: Energy-efficient techniques (e.g., drip irrigation). • Discuss on: Government subsidies and schemes (PM-KUSUM, Biogas schemes).

References:	
	1. *Textbook of Environmental Studies for Undergraduate Courses* by Erach Bharucha, Universities Press, Hyderabad. 2. *Traditional Water Management Systems of India* by Anupam Mishra, Mapin Publishing Pvt. Ltd., Ahmedabad. 3. *Principles of Agronomy* by S. R. Reddy and R. Reddy, Kalyani Publishers, New Delhi. 4. *Agricultural Energy Use and the Environment* by N. K. Tyagi, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi. 5. *Soil Science: An Introduction* by D. K. Das, Kalyani Publishers, New Delhi. 6. *Solar Energy: Fundamentals, Design, Modelling and Applications* by G. N. Tiwari, Narosa Publishing House, New Delhi. 7. *PM-KUSUM, Solar Pumps and Biogas Programme Reports and Booklets* by Ministry of New and Renewable Energy (MNRE), Government of India, New Delhi. 8. *Extension Booklets on Organic and Sustainable Agriculture* by Indian Council of Agricultural Research (ICAR), New Delhi.

Model questions for theory external/ internal examination.	
One sentence/ Very short answer questions (1 Mark)	1. Define soil moisture. 2. What is drip irrigation? 3. Define greenhouse effect. 4. What is remote sensing? 5. What is solar dryer?
Short answer questions (3 Marks)	1. Explain the role of physics in irrigation systems. 2. Describe greenhouse technology in agriculture. 3. Explain applications of solar energy in agriculture. 4. Explain the principle of remote sensing. 5. Compare traditional irrigation and drip irrigation methods.
Long Answer Questions (6 Marks)	1. Discuss the applications of physics in modern agriculture. 2. Explain greenhouse effect and greenhouse technology in agriculture. 3. Describe different renewable energy sources used in agriculture. 4. Analyse the role of remote sensing in precision farming. 5. Explain modern irrigation techniques and their advantages.

Physics VSC-3 Lab/Practical – 129228	
Mobile Repairing Technician	
Credits: 02	**Workload (Hrs./Week): 04**
Course Objectives:	1. Diagnose and fix common hardware issues (displays, batteries, charging ports, speakers) through hands-on disassembly and soldering techniques. 2. Troubleshoot OS failures, perform firmware flashing (Android/iOS), bypass FRP locks, and repair IMEI/baseband errors. 3. Troubleshoot power circuits, replace ICs, and repair water-damaged devices using micro-soldering and jumper techniques. 4. Complete practical repairs on live faulty devices, from screen replacements to motherboard troubleshooting. 5. Build confidence to launch a repair business or work in service centers, with knowledge of tools, safety, and customer service basics.
Course Outcomes:	After completing the course, the student will be able to: 1. Replace broken displays (LCD/OLED), batteries, charging ports, and speakers. 2. Fix power issues (dead phone, overheating) using multimeter and soldering techniques. 3. Flash stock/custom ROMs using Odin, SP Flash Tool, and iTunes. 4. Bypass FRP (Google Lock) and repair IMEI/network issues. 5. Repair water-damaged phones and replace faulty ICs (charging IC, WiFi/BT IC). 6. Perform microsoldering and jumper wire repairs on PCBs. 7. Extract data from locked/crashed phones using software/hardware methods. 8. Understand service center operations, pricing strategies, and customer handling

Unit	Theoretical Background	Lab/ Practical/ Demonstrations/Activities
I	**Basics & Hardware:** Introduction to mobile phones (Android, iOS); Basic electronics (voltage, current, resistance); Tools & safety (multimeter, soldering, ESD protection); Mobile components (display, battery, PCB, sensors, microphone, speaker and camera,)	1. Disassemble/assemble phones (screw patterns, adhesives) 2. Identify faulty components using diagrams 3. Use multimeter to test battery, charging port, fuses
II	**Software & Flashing:** Mobile OS architecture (Android/iOS); Common software issues (bootloop, hang, virus); Flashing tools (Odin, SP Flash Tool, iTunes); FRP bypass, IMEI repair, jailbreaking (basics)	4. Flash firmware on dead/bricked phones 5. Remove FRP lock on Android devices 6. Factory reset & software troubleshooting
III	**Hardware Repair**: Display types (LCD, OLED) & touch issues; Charging circuit (IC, port, coil); Audio/speaker, microphone, camera, network problems; Water damage treatment	7. Replace broken screens (glass + digitizer) 8. Solder charging ports & jumper wires 9. Fix no-power issues (dead phone 10. Repair speaker/microphone issues
IV	**Advanced Troubleshooting:** Micro-soldering & BGA reballing (concepts); Data recovery from damaged phones; Business tips (service center setup, pricing)	11. Practice IC rework (under microscope) 12. Real-case repairs (students bring faulty phones) 13. Final assessment: Diagnose & fix 3 faults

References:	1. *Mobile Repairing Course Guide: Hardware Repair, Circuit Diagrams and Troubleshooting* by Manohar Lotia, BPB Publications, New Delhi. 2. *Step-by-Step Repair Guide for Android and iPhone* by Nitesh Kumar, Techinaut Books, New Delhi. 3. *Mobile Repairing: Basic to Advanced Repairs, Tools and Safety* by P. K. Ghosh, Satya Prakashan, New Delhi. 4. *Mobile Repairing and Troubleshooting: Circuit Tracing, Soldering and Fault Finding* by P. Babu, Dreamtech Press, New Delhi. 5. *Mobile Repairing for Beginners: A Simplified Guide for Entry-Level Technicians* by Rajiv Sharma, Kindle Edition.

Physics FP/CES-2 Project – 129229	
Field Project / CE Services in Physics: Phase-II	
Credits: 02	**Workload (Hrs./Week): 04**
Course Objectives:	1. To provide hands-on experience in applying theoretical physics knowledge to real-world challenges through field-based projects or community engagement (CE) services. 2. To train students in identifying, analyzing, and solving practical problems encountered in physics-related fieldwork or community service activities. 3. To encourage students to integrate physics concepts with interdisciplinary knowledge, technology, and societal needs. 4. To develop students' abilities to document, present, and communicate their field-based or community engagement work effectively to diverse audiences. 5. To instill a sense of responsibility and service by involving students in projects that address community issues related to science and technology.
Course Outcomes:	1. Students will be able to apply physics principles and analytical techniques to investigate and solve real-world problems in field settings. 2. Students will demonstrate proficiency in using experimental tools, instruments, and data analysis methods relevant to their field project or CE service. 3. Students will be able to design, plan, and execute a field project or community service activity from inception to completion, including documentation and reporting. 4. Students will effectively communicate their project findings and outcomes through written reports, presentations, or community engagement events. 5. Students will demonstrate an understanding of the ethical, environmental, and societal impacts of their work, showing a commitment to responsible scientific practice and community well-being.
• **Guidelines/SOP for Selection and Implementation of Field Projects / CE Services**	
1. Project Selection and Planning	• **Faculty Guidance:** Students will be assigned a faculty mentor to guide their project, providing expertise and resources. • **Project Topic:** The project topic should be relevant to physics and align with the student's interests and the available resources. • **Literature Review:** Students are expected to conduct a thorough literature review to understand existing knowledge and identify research gaps. • **Data Collection and Analysis:** Projects often involve experiments, simulations, or data analysis from existing sources, depending on the topic. • **Project Timeline:** The total time allocation for the student to carry out field project is 60 hours.
2. Data Analysis and Interpretation	• **Statistical Methods:** Students will learn and apply appropriate statistical methods to analyze data. • **Interpretation of Results:** Data should be interpreted within the context of the project, highlighting significant findings and limitations.
3. Report Writing and Presentation	• **Report Format:** A structured report format is usually followed, including an abstract, introduction, methodology, results, discussion, and conclusion.

	• **Data Presentation:** Data should be presented clearly and accurately using tables, graphs, and figures. • **Oral Presentation:** Students will be required to present their findings to peers and faculty.
4. CE Services (Community Engagement)	• **Community Needs:** Projects may focus on addressing specific community needs or challenges relevant to physics. • **Collaboration:** Students can collaborate with local organizations to implement their projects. • **Impact Assessment:** The impact of the project on the community should be evaluated.
5. Evaluation and Assessment	• **Project Report:** The final report will be assessed based on its content, organization, and the quality of the research. **(20 Marks)** • **Oral Presentation:** The presentation will be evaluated on clarity, engagement, and the ability to answer questions. **(10 Marks)** • **Faculty Evaluation:** The faculty mentor will assess the student's performance throughout the project. **(20 Marks)** • **Total 50 Marks**
Examples of Field Projects/CE Services in Physics	• **Environmental Physics:** Studying the impact of pollution on local ecosystems or developing renewable energy solutions. • **Health Physics:** Investigating the effects of radiation on human health or developing medical imaging technologies. • **Education:** Designing physics experiments or teaching physics to younger students. • **Community Outreach:** Organizing science workshops or engaging in scientific literacy initiatives. • **Research Project:** Study related to the subject Physics that contribute to the advancement of knowledge and the well-being of life on Earth.

Note: The extended portion of the Field Project/CE Services in Physics from Phase-I may be carried forward as Field Project/CE Services in Physics: Phase-II in the fourth semester, subject to the approval of the assigned faculty mentor.

The objectives of the project shall be decided phase-wise and a project report must be submitted at the end of every semester.

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI

Three/Four Years – Six/Eight Semesters Bachelor's Degree Programme
3 Years B.Sc. / 4 Years B.Sc. (Hons.) & 4 Years B.Sc. (Hons. with Research) Programme

Faculty of
Science and Technology
(Science Group)

Subject: **PHYSICS**
(Semesters V and VI)

Effective from Academic Year 2026-27
(As per NEP 2020)

Contents

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI
FACULTY: Science and Technology
Subject: PHYSICS
Teaching and Learning Scheme for the Degree of Bachelor of Science (B.Sc.)
<u>Three Years / Four Years - (Six/Eight Semesters) Bachelor Degree Programme</u>

Examination, Evaluation and Assessment Scheme

Vertical No.	The Vertical	Mode of Examination, Evaluation & Assessment	Theory					Theory (Total)		Practical					Practical (Total)	
			External			Internal				External			Internal			
			Max. Marks	Min. Marks	Duration (Hrs.)	Max. Marks	Min. Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks	Duration (Hrs.)	Max. Marks	Min. Marks	Max. Marks	Min. Marks
A	**Major**	**External & Internal**	**30**	**9**	**2**	**20**	**6**	**50**	**20**	**25**	**10**	**3**	**25**	**10**	**50**	**20**
	IKS Major Specific		**30**	**9**	**2**	**20**	**6**	**50**	**20**	**-**	**-**	-	**-**	**-**	**-**	**-**
B	**Minor**		**30**	**9**	**2**	**20**	**6**	**50**	**20**	**25**	**10**	**3**	**25**	**10**	**50**	**20**
C	**Generic/ Open Elective**	**Internal**	**-**	**-**	-	**50**	**20**	**50**	**20**	**--**	**--**	-	**--**	**--**	**--**	**--**
D	**VSC**	**Internal**	**--**	**--**	-	-	-	-	-	**--**	**--**	-	**50**	**20**	**50**	**20**
	SEC	**Internal**	**--**	**--**	-	-	-	-	-	**--**	**--**	-	**50**	**20**	**50**	**20**
F	**Internship/ Apprenticeship**	**Internal**	Assessment of these verticals shall be based on various activities/practices. It shall be evaluated by giving maximum marks of 50 per 2 Credit Course with separate activity weightages/levels. A detailed SOP for this assessment process shall be prescribed separately.													
	FP/CEP															
	CC															

Internal Assessment for Theory/Practical/Laboratory:

All the internal assessments should be conducted on the basis of Continuous Assessment Tests (CAT).

Continuous Assessment Tests (CAT):

For internal assessment, the Continuous Assessment Tests (CAT) shall be conducted as under

i. Three CAT each of 10 Marks (Theory) and 10 Marks (Practical).
   - First on completion of 25% Syllabus of the course or on completion of 25 teaching days,
   - Second on completion of 50% Syllabus of the course or on completion of 50 teaching days,
   - Third on completion of 75% Syllabus of the course or on completion of 75 teaching days.

ii. Each concurrent assessment (CAT-I, II & III) will be mapped to relevant Course Learning Outcome.

iii. Total Performance in CAT (i.e.40 %) shall be based on the best two out of three in CAT examinations

iv. Internal assessment shall be carried out by the respective course teacher by choosing variety of assessment tools/methods such as class test, seminar, case study, field work, mini project work, quiz or any innovative method, which may be deemed to be appropriate for assessing the relevant course outcome.

External Assessment for Practical (Major/Minor Lab):

- Experiment Performance : 20 Marks
- Viva-Voce : 05 Marks
- **Total : 25 Marks**
- Duration of Examination : 03 Hrs.

Internal Assessment for Practical (Major/Minor Lab):

- Internal Assessment based on CAT : 20 Marks
- Record Book : 05 Marks
- **Total : 25 Marks**

Internal Assessment for OE:

- Internal Assessment based on CAT : 20 Marks
- End Semester Examination : 30 Marks
- **Total : 50 Marks**
- Duration of End Semester Examination : 02 Hrs.

Internal Assessment for Practical (SEC/VSC Lab):

- Internal Assessment based on CAT : 20 Marks
- Record Book : 10 Marks
- End Semester Examination : 20 Marks
  (Experiment/ Demonstration/ Hands on Activity Performance: 15 Marks + Viva-Voce: 05 Marks)
- **Total : 50 Marks**
- Duration of End Semester Examination : 03 Hrs.

Note: The external assessments of theory courses will be conducted in accordance with the guidelines issued by the SGBA University.

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI
FACULTY: Science and Technology
Subject: PHYSICS
Teaching and Learning Scheme for the Degree of Bachelor of Science (B.Sc.)
Three Years / Four Years - (Six/Eight Semesters) Bachelor Degree Programme

THIRD YEAR: Level 5.5 - SEMESTER – V (T & L Credit Scheme)

Mode of Teaching	Vertical No	The Vertical	Type of Course	Course Code	Course Name	Credits	Workload (Hrs/Week)	Vertical Workload (Hrs/Week)
Classroom Teaching/ Lab Work (Practical/ Outdoor/ Field/Online/Hybrid)	A	Major	Physics MJ Theory 8	129230	Atomic and Molecular Physics	2	2	**10**
			Physics MJ Theory 9	129231	Network Theorems and Statistical Mechanics	2	2	
			Physics MJ Theory 10	129232	Solid State Physics I	2	2	
			Physics MJ Lab/Practical 5	129233	Experiments related to MJ Th8, Th9 and Th10	2	4	
		Elective 1(a) or 1(b)	Physics EL Theory 1(a)	129234	Digital Electronics - I	2	2	**6**
			Physics EL Theory 1(b)	129235	Python Programming - I	2	2	
			Physics EL Lab/Practical 1(a)	129236	Experiments related to Digital Electronics - I	2	4	
			Physics EL Lab/Practical 1(b)	129237	Experiments related to Python Programming - I	2	4	
	B	Minor	Physics MN Theory 5	129238	Solid State Physics and Network Theorems	2	2	**6**
			Physics MN Lab/Practical 5	129239	Experiments related to MN Th5	2	4	
	C	Generic/ Open Elective	-	-	--	0	0	**0**
	D	VSC	Physics VSC-4 Lab/Practical	129240	Maintenance and Repairing of Domestic Appliances	2	4	**8**
		SEC	Physics SEC-3 Lab/Practical	129241	Fundamentals of Computer Applications in Physics Laboratory and Scilab Programming	2	4	
	E	AEC				-	-	**0**
		IKS (Generic)				-	-	
		VEC				-	-	
	F	Internship/ Apprenticeship/ OJT				0	0	**4**
		FP/CES	Physics FP/CES-2 Project	129242	Field Project / CE Services	2	4	
		CC				0	0	
Total						**22**	**34**	**34**

Physics MJ Theory 8 – 129230	
Atomic and Molecular Physics	
Credits: 02	**Workload (Hrs./Week): 02**
Course Objectives:	1. To understand the fundamental concepts of atomic structure, vector atom model, and quantum numbers. 2. To apply Pauli exclusion principle and electronic configuration in atomic systems. 3. To understand coupling schemes, spin–orbit interaction, and spectral terms in atomic spectra. 4. To analyse spectra of hydrogen-like atoms, sodium atom, and helium atom using quantum principles. 5. To study the origin and characteristics of X-ray spectra and Raman spectra. 6. To understand the production, classification, and applications of X-rays and Raman effect. 7. To interpret molecular energy levels using rigid rotor and harmonic oscillator models. 8. To develop problem-solving ability related to atomic and molecular spectroscopy.
Course Outcomes:	By the end of the course, students will be able to: 1. Explain the vector atom model and interpret quantum numbers and atomic states. 2. Describe electron spin, magnetic moments, and space quantization phenomena. 3. Apply Pauli exclusion principle and determine electronic configurations of atoms. 4. Analyse atomic spectra using L–S coupling, J–J coupling, and selection rules. 5. Explain spin–orbit interaction and spectral splitting in sodium and helium atoms. 6. Interpret characteristic and continuous X-ray spectra and apply Duane–Hunt law and Moseley's law. 7. Describe the Raman effect and explain the origin and characteristics of Raman spectra. 8. Explain rotational, vibrational, and electronic spectra of diatomic molecules. 9. Apply rigid rotor and harmonic oscillator models to molecular spectroscopy problems. 10. Solve numerical and conceptual problems related to atomic and molecular physics.

Unit	Contents	Work-load Allotted	Weight-age of Marks Allotted	Incorporation of Pedagogies
I	Brief introduction to earlier atomic models (qualitative), Vector atom model, space quantization, and electron spin; quantum numbers; magnetic moments; Larmor theorem; Stern–Gerlach experiment. Pauli exclusion principle and electron configuration. Quantum states. Spectroscopic notation of quantum states	7 Hrs	8 Marks	1. Lecture method with board teaching 2. Concept-based interactive teaching 3. Demonstration using atomic models and diagrams 4. Numerical problem-solving sessions 5. Question–answer discussions 6. ICT-enabled teaching using animations/simulations 7. Tutorial sessions for quantum numbers and spectral notation
II	Spin–orbit interaction (single valence electron atom); energy levels of the Na atom; selection rules; spectra of sodium atom; sodium doublet; spectral terms of two-electron atoms; terms of equivalent electrons; L–S and J–J coupling schemes; Zeeman effect & Stark effect (qualitative)	8 Hrs	8 Marks	1. Lecture-cum-discussion method 2. Spectral term derivation practice 3. Problem-solving and numerical sessions 4. Comparative analysis of coupling schemes 5. Group discussion on atomic spectra 6. Use of charts, energy level diagrams, and simulations 7. Assignment-based learning
III	**X-ray-** Production, origin of continuous and characteristic X-ray emission spectra; Duane–Hunt law. K, L, M, and N series. Comparison of X-ray and optical spectra; Moseley's law and its applications. **Raman effect-** experimental arrangement to observe Raman spectra; Stokes and Anti-stokes lines, Raman Shift, quantum theory of Raman effect.	8 Hrs	8 Marks	1. Lecture method with multimedia presentations 2. Experimental demonstration/videos of X-ray and Raman setup 3. Analytical discussion of spectra 4. Numerical problem-solving on Duane–Hunt law and Moseley's law 5. ICT-enabled teaching using spectral images and animations 6. Inquiry-based learning through applications of X-rays and Raman effect 7. Seminar/presentation activities by students
IV	Introduction to molecular spectra (rotational, vibrational, and electronic); rotational spectra of diatomic molecules; rotational energy levels of rigid diatomic molecules. Vibrational energy levels of diatomic molecules; Harmonic oscillator model and its energy levels; rotational–	7 Hrs	8 Marks	1. Lecture and interactive teaching 2. Mathematical derivation and numerical practice 3. Use of molecular models and energy level diagrams 4. Simulation-based teaching for rotational and vibrational spectra 5. Tutorial sessions on rigid rotor and harmonic oscillator models

	vibrational spectra of diatomic molecules, Numerical.			6. Problem-solving sessions.

References:	1. Brijlal and N. Subrahmanyam, *Atomic and Nuclear Physics*, S. Chand Publishing, New Delhi. 2. J. B. Rajam, *Atomic Physics*, S. Chand Publishing, New Delhi. 3. Ajoy Ghatak, *Atomic and Molecular Physics*, Tata McGraw-Hill Education, New Delhi. 4. S. N. Ghoshal, *Atomic Physics*, S. Chand Publishing, New Delhi. 5. D. P. Khandelwal, *Atomic and Molecular Physics*, Himalaya Publishing House, Mumbai. 6. R. Murugeshan and Kiruthiga Sivaprasath, *Modern Physics*, S. Chand Publishing, New Delhi. 7. P. S. Hemne, *Atomic and Molecular Physics*, Tata McGraw-Hill Education, New Delhi.

Model questions for theory external/ internal examination.	
One sentence/ Very short answer questions (1 Mark)	1. Define space quantization. 2. State Pauli exclusion principle. 3. What is spin–orbit interaction? 4. State Duane–Hunt law. 5. What is Raman shift?
Short answer questions (3 Marks)	1. Explain the physical significance of quantum numbers. 2. Differentiate between L–S coupling and J–J coupling. 3. Explain the origin of characteristic X-rays. 4. Describe the experimental arrangement used to observe Raman spectra. 5. Explain rigid rotator models for diatomic molecules.
Long Answer Questions (6 Marks)	1. Explain the Stern–Gerlach experiment and discuss its importance in proving space quantization. 2. Derive the expression for spin–orbit interaction energy and explain sodium doublet formation. 3. Discuss the origin of continuous and characteristic X-ray spectra. Explain Moseley's law and its applications. 4. Explain the quantum theory of Raman effect with suitable energy level diagram. 5. Derive the rotational energy levels of a rigid diatomic molecule and discuss rotational spectra.

Physics MJ Theory 9 – 129231	
Network Theorems and Statistical Mechanics	
Credits: 02	**Workload (Hrs./Week): 02**
Course Objectives:	1. To develop understanding of electrical network theorems and analysis of electrical circuits. 2. To explain transient and alternating current phenomena in LR, CR, and LCR circuits. 3. To introduce concepts of reactance, impedance, resonance, resonant frequency, and Q-factor in AC circuits. 4. To develop analytical and numerical problem-solving skills related to electrical and electronic circuits. 5. To understand the basic concepts of statistical mechanics such as phase space, microstates, macrostates, and probability. 6. To explain Maxwell–Boltzmann, Bose–Einstein, and Fermi–Dirac statistics and their physical significance. 7. To study the properties of distinguishable and indistinguishable particles, bosons, and fermions. 8. To develop conceptual understanding of black body radiation, molecular speed distribution, and Fermi energy concepts.
Course Outcomes:	At the end of the course, students will be able to: 1. Apply Kirchhoff's laws and network theorems to analyse electrical circuits. 2. Solve problems related to LR, CR, and LCR circuits under transient and AC conditions. 3. Explain the concepts of reactance, impedance, resonance, resonant frequency, and Q-factor in AC circuits. 4. Analyse AC circuits using phasor representation and mathematical techniques. 5. Describe the concepts of phase space, microstates, macrostates, and thermodynamic probability. 6. Apply Maxwell–Boltzmann statistics to molecular speed distribution and related parameters. 7. Differentiate between distinguishable and indistinguishable particles, bosons, and fermions. 8. Explain Bose–Einstein and Fermi–Dirac statistics and their applications to physical systems.

Unit	Contents	Work-load Allotted	Weight-age of Marks Allotted	Incorporation of Pedagogies
I	Kirchhoff's laws and analysis of multi-loop circuits; superposition theorem (mesh current analysis); Thevenin's theorem; Norton's theorem; maximum power transfer theorem and its applications; numerical.	7 Hrs	8 Marks	• Lecture-cum-discussion method • Circuit diagram demonstration • Numerical problem-solving method • ICT-based teaching • Interactive learning approach
II	Rise and decay of current in LR circuits; charging and discharging of capacitor in CR circuits; transient response in LCR circuits. Alternating current and voltage; AC circuits containing resistor, inductor, and capacitor; LR, CR, and LCR circuits; phasor representation; reactance; impedance; resonance in LCR circuit; resonant frequency and Q-factor; numerical.	8 Hrs	8 Marks	• Conceptual teaching method • Phasor diagram representation • Demonstration using AC circuit models • Numerical practice sessions • Simulation-based teaching
III	Phase space, unit cell, macrostates, microstates, energy states, density of energy states, probability and thermodynamic probability, principle of equal a priori probabilities, most probable distribution, and Boltzmann entropy relation. Maxwell–Boltzmann statistics and its application to molecular speed distribution; average speed, RMS speed, and most probable speed.	8 Hrs	8 Marks	• Lecture and explanation method • Graphical representation approach • Analytical teaching method • Problem-solving sessions • Conceptual discussion method
IV	Distinguishable and indistinguishable particles. Bose–Einstein statistics: Concepts of bosons, thermodynamic probability, most probable distribution, and application of Bose–Einstein statistics to black body radiation. Fermi–Dirac statistics: Concepts of fermions, thermodynamic probability, most probable distribution, Fermi function, Fermi energy, and Fermi temperature.	7 Hrs	8 Marks	• Comparative teaching method • Conceptual and analytical approach • Graphical interpretation method • Numerical problem-solving • Seminar/presentation activities

References:	1. Basic Electronics: Solid State, B. L. Theraja, S. Chand Publications. 2. Principles of Electronics, V. K. Mehta and Rohit Mehta, S. Chand Publications. 3. Electronic Devices and Circuits: An Introduction, Allen Mottershead, PHI Learning. 4. Elements of Statistical Mechanics, Kamal Singh, S. Chand Publications. 5. Statistical Mechanics, B. K. Agarwal and M. Eisner, New Age International Publishers. 6. Fundamentals of Statistical Mechanics, B. B. Laud, New Age International Publishers. 7. Statistical Mechanics, S. L. Gupta and V. Kumar, Pragati Prakashan. 8. Heat, Thermodynamics and Statistical Physics, Brij Lal and N. Subrahmanyam, S. Chand Publications. 9. Refresher Course in B.Sc. Physics (Vol. II), C. L. Arora, S. Chand Publications.

Model questions for theory external/ internal examination.	
One sentence/ Very short answer questions (1 Mark)	1. State Kirchhoff's current law (KCL). 2. Define impedance in an AC circuit. 3. What is resonant frequency? 4. Define microstate in statistical mechanics. 5. What is meant by Fermi energy?
Short answer questions (3 Marks)	1. Explain the statement of Thevenin's theorem with its significance. 2. Distinguish between reactance and impedance. 3. Explain resonance in a series LCR circuit. 4. Describe the concept of phase space and unit cell. 5. Differentiate between bosons and fermions.
Long Answer Questions (6 Marks)	1. Derive the condition for maximum power transfer theorem and explain its applications. 2. Explain charging and discharging of a capacitor in a CR circuit with necessary equations and graphs. 3. Discuss AC circuits containing resistor, inductor, and capacitor using phasor representation. 4. Derive Maxwell–Boltzmann distribution law and explain molecular speed distribution. 5. Explain Bose–Einstein statistics and its application to black body radiation.

<table>
<tr><th colspan="2">Physics MJ Theory 10 – 129232</th></tr>
<tr><th colspan="2">Solid State Physics - I</th></tr>
<tr><th>Credits: 02</th><th>Workload (Hrs./Week): 02</th></tr>
<tr><td>Course Objectives:</td><td>1. To introduce students to the fundamental concepts of crystalline and amorphous solids and crystal structures.
2. To develop understanding of lattice geometry, unit cells, crystal systems, Bravais lattices, and Miller indices.
3. To explain X-ray diffraction techniques and their applications in crystal structure analysis.
4. To familiarize students with different types of crystal defects and their effects on material properties.
5. To develop understanding of magnetic properties of materials and the origin of magnetism.
6. To explain magnetic parameters such as magnetic field strength, magnetization, permeability, and susceptibility.
7. To introduce different classes of magnetic materials such as diamagnetic, paramagnetic, ferromagnetic, ferrimagnetic, and antiferromagnetic materials.
8. To explain Langevin's theories, Curie law, Weiss molecular field theory, and domain theory of ferromagnetism.
9. To develop understanding of hysteresis, Curie temperature, ferrites, and applications of magnetic materials.
10. To enhance analytical ability and problem-solving skills through numerical applications related to crystallography and magnetism.</td></tr>
<tr><td>Course Outcomes:</td><td>At the end of the course, students will be able to:
1. Explain the structure and properties of crystalline and amorphous solids.
2. Describe crystal systems, Bravais lattices, unit cells, and Miller indices used in crystallography.
3. Calculate coordination number, packing fraction, atomic radius, and volume of unit cells through numerical problems.
4. Explain the principles of X-ray diffraction and analyse crystal structures using Bragg's law and diffraction methods.
5. Identify different types of crystal defects and discuss their effects on material properties.
6. Understand the origin of magnetic moment and explain magnetic parameters such as magnetic field strength, magnetization, permeability, and susceptibility.
7. Classify magnetic materials into diamagnetic, paramagnetic, ferromagnetic, ferrimagnetic, and antiferromagnetic materials.
8. Explain Langevin's theories of diamagnetism and paramagnetism, Curie law, and Weiss molecular field theory.
9. Describe hysteresis behaviour, Curie temperature, ferrites, and applications of magnetic materials.
10. Develop analytical, numerical, and problem-solving skills related to crystallography and magnetic properties of materials.</td></tr>
</table>

Unit	Contents	Work-load Allotted	Weight-age of Marks Allotted	Incorporation of Pedagogies
I	**Crystallography – I:** Amorphous and crystalline solids; Lattice; Unit cell; Primitive and non-primitive unit cells; Seven crystal systems; Bravais lattices; Properties of unit cell: coordination number, atoms per unit cell, atomic radius, packing fraction, and volume of a unit cell; Miller indices; Numerical.	8 Hrs	8 Marks	• Use crystal models and charts to explain lattice and unit cell concepts. • Demonstrate crystal systems and Bravais lattices using visual aids. • Conduct numerical sessions on packing fraction and coordination number. • Use diagrams for explaining Miller indices. • Encourage classroom discussions and conceptual questioning.
II	**Crystallography – II:** Diffraction of X-rays by crystals; Bragg's law; Laue method; Powder diffraction method; Reciprocal lattice; Crystal defects: point defects, line defects, and plane defects; Numerical.	7 Hrs	8 Marks	• Explain X-ray diffraction using animations and diffraction patterns. • Demonstrate Bragg's law through numerical problems. • Use models and videos for Laue and powder diffraction methods. • Discuss crystal defects with suitable illustrations. • Conduct problem-solving sessions on diffraction and crystal parameters.
III	**Magnetic Properties of Materials – I:** Origin of magnetic moment; Magnetic field strength (H), magnetic induction (B), and magnetization (M); Magnetic permeability (μ) and magnetic susceptibility (χ); Relation between B, H, and M; Classification of magnetic materials: diamagnetic materials, paramagnetic materials, and ferromagnetic materials; Langevin's theory of diamagnetism; Langevin's theory of paramagnetism; Curie law and Curie constant.	8 Hrs	8 Marks	• Use lecture-cum-discussion method for magnetic concepts. • Explain magnetic parameters using diagrams and examples. • Demonstrate classification of magnetic materials through charts. • Teach Langevin's theories with conceptual derivations. • Conduct numerical exercises on Curie law and magnetic susceptibility.
IV	**Magnetic Properties of Materials – II:** Ferromagnetism; Weiss molecular	7 Hrs	8 Marks	• Explain ferromagnetism and domain theory using animations. • Use hysteresis loop diagrams to

	field theory; Domain theory of ferromagnetism; Curie temperature; Hysteresis curve and hysteresis loss; Soft and hard magnetic materials; Applications of magnetic materials; Introduction to ferrimagnetic and antiferromagnetic materials; Ferrites: properties and applications.			discuss magnetic behaviour. • Compare soft and hard magnetic materials with real-life examples. • Discuss applications of ferrites and magnetic materials. • Encourage student presentations and short quizzes on magnetic materials.

References:	1. *A Textbook of Crystallography* by P. K. Ghosh; S. Chand Publishing. 2. *Crystallography and Solid State Physics* by S. Raghunathan and M. Venkataraman; S. Chand Publishing. 3. *Solid State Physics: Structure and Properties of Materials* by M. A. Wahab; Narosa Publishing House. 4. *Introduction to Solid State Physics* by Charles Kittel, 8th Edition; Wiley Publication. 5. *Solid State Physics* by N. W. Ashcroft and N. D. Mermin; TMH Publication. 6. *Solid State Physics* by J. S. Blakemore, 2nd Edition; Cambridge University Press. 7. *Solid State Physics* by C. L. Arora; S. Chand Publishing. 8. *Solid State Physics* by S. O. Pillai; New Age International Publishers. 9. *Solid State Physics* by A. J. Dekker, 8th Edition; Macmillan India Ltd. 10. *Elementary Solid State Physics* by M. Ali Omar; Pearson Education. 11. *Elements of Solid State Physics* by J. P. Srivastava; PHI Learning. 12. *Solid State Physics* by S. L. Kakani and C. Hemrajani; S. Chand Publishing. 13. *Solid State Physics* by R. C. Gupta, P. Saxena, and M. Saxena; Pragati Prakashan. 14. *Solid State Physics* by R. K. Puri and V. K. Babbar; S. Chand Publishing. 15. *Problems in Solid State Physics* by S. O. Pillai; New Age International Publishers. 16. *Solid State Physics* by P. K. Palanisamy; Scitech Publications. 17. *Solid State Physics: Essentials and Beyond* by David Snoke; Pearson Education. 18. *Materials Science* by M. Arumugam; Anuradha Agencies. 19. *Introduction to Crystallography* by Donald E. Sands; Indian Edition. 20. *Solid State Physics and Electronics* by A. J. Dekker; Macmillan India Ltd. 21. *Engineering Physics* by M. N. Avadhanulu and P. G. Kshirsagar; S. Chand Publishing. 22. *A Textbook of Engineering Physics* by R. K. Gaur and S. L. Gupta; Dhanpat Rai Publications.

Model questions for theory external/ internal examination.	
One sentence/ Very short answer questions (1 Mark)	1. Define a unit cell. 2. What is meant by Miller indices? 3. State Bragg's law. 4. Define magnetic susceptibility. 5. What is Curie temperature?
Short answer questions (3 Marks)	1. Differentiate between amorphous and crystalline solids. 2. Explain the significance of coordination number and packing fraction in crystal structure. 3. Describe the powder diffraction method used in crystallography. 4. Explain Langevin's theory of diamagnetism. 5. Differentiate between soft magnetic and hard magnetic materials with suitable examples.
Long Answer Questions (6 Marks)	1. Explain the seven crystal systems and Bravais lattices with neat diagrams. 2. Derive Bragg's law and discuss its importance in crystal structure analysis. 3. Explain different types of crystal defects and discuss their effects on material properties. 4. Discuss Weiss molecular field theory and domain theory of ferromagnetism. 5. Explain hysteresis curve, hysteresis loss, and applications of magnetic materials.

<table>
<tr><th colspan="2">Physics MJ Lab/ Practical 5 – 129233</th></tr>
<tr><th colspan="2">Experiments related to MJ Th8, Th9 and Th10</th></tr>
<tr><th>Credits: 02</th><th>Workload (Hrs./Week): 04</th></tr>
<tr><td>Course Objectives:</td><td>1. To develop experimental skills in atomic, molecular, electrical, and solid-state physics through systematic laboratory investigations.
2. To understand the principles of atomic spectra, molecular spectra, and quantum phenomena by performing spectroscopic experiments and analysing experimental data.
3. To verify and apply fundamental electrical network theorems such as Kirchhoff’s laws, Thevenin’s theorem, Norton’s theorem, superposition theorem, and maximum power transfer theorem in practical circuits.
4. To study the behaviour of AC and DC electrical circuits involving resistance, capacitance, and inductance, and to analyse resonance, impedance, phase relationships, transient response, and filter characteristics.
5. To gain practical knowledge of RC, LR, and LCR circuits and determine important electrical parameters such as time constants, resonant frequency, Q-factor, reactance, capacitance, and inductance.
6. To develop competence in handling laboratory instruments such as spectrometers, power supplies, multimeters, CROs, function generators, transformers, and X-ray diffraction setups.
7. To understand crystal structure and solid-state properties through the study of crystal models, X-ray diffraction patterns, lattice parameters, magnetic properties, and superconductivity.
8. To investigate magnetic behaviour of materials by determining magnetic susceptibility and studying hysteresis curves and magnetic losses in ferromagnetic materials.</td></tr>
<tr><td>Course Outcomes:</td><td>By the end of this course, students will be able to:
1. Perform spectroscopic experiments to analyse atomic and molecular spectra and determine physical constants such as the Rydberg constant, dissociation energy, and force constant.
2. Apply and experimentally verify fundamental electrical network theorems including Kirchhoff’s laws, Thevenin’s theorem, Norton’s theorem, superposition theorem, and maximum power transfer theorem.
3. Analyse the behaviour of AC and DC circuits involving R, L, and C components and determine electrical parameters such as impedance, reactance, resonant frequency, phase difference, and Q-factor.
4. Investigate transient phenomena in RC, LR, and LCR circuits including charging, discharging, rise and decay processes, and determination of time constants.
5. Study resonance characteristics and filter behaviour in electrical circuits and interpret resonance curves and frequency response experimentally.
6. Demonstrate the ability to use laboratory instruments, electrical components, spectrometers, CROs, transformers, and X-ray diffraction data analysis techniques effectively and safely.
7. Explain crystal structures, identify crystal planes, and determine lattice parameters and crystallite size using X-ray diffraction methods.
8. Investigate magnetic properties of materials through experiments on hysteresis, magnetic susceptibility, superconductivity, and B–H curves.</td></tr>
</table>

List of Experiments: Perform minimum eight (8) experiments from the given list. (at least 2 experiments related to each theory paper)
1. To determine the Rydberg constant using the hydrogen spectrum. 2. To study the absorption spectra of iodine vapour and to determine its dissociation energy and force constant. 3. To estimate the temperature of sodium flame by studying the reversal of the spectral lines (D-lines) 4. Verification of Thevenin's theorem. 5. Verification of Norton's theorem. 6. Verification of maximum power transfer theorem. 7. Verification of superposition theorem. 8. Verification of Kirchhoff's laws using electrical networks. 9. Measurement of inductance by phasor diagram method. 10. Measurement of capacitance by phasor diagram method. 11. Study of frequency resonance in a series LCR circuit and determination of Q-factor. 12. Study of RC circuit as a filter. 13. Determination of time constant of an RC circuit. 14. Determination of high resistance by leakage method. 15. Study of rise and decay of current in an LR circuit. 16. Study of charging and discharging of a capacitor in an RC circuit. 17. Determination of impedance and reactance in AC circuits. 18. Study of phase difference between current and voltage in LR, CR, and LCR circuits. 19. Verification of resonance condition in a parallel LCR circuit. 20. Plotting of resonance curve for an LCR circuit. 21. Study of transient response in LCR circuits. 22. Determination of resonant frequency of an LCR circuit. 23. To study crystal models and identification of crystal planes. 24. To study hysteresis loss in a transformer core and plot the B–H curve. 25. To determine lattice parameters using X-ray diffraction patterns. 26. To analyse given X-ray diffraction data and estimate the crystallite size of nanomaterials. 27. To determine the magnetic susceptibility of a magnetic material using Gouy's balance method. 28. To determine the magnetic susceptibility of a liquid using Quincke's method. 29. To draw the B–H curve or hysteresis loop for a given ferromagnetic material. 30. To determine Curie temperature of ferromagnetic material.

References:	1. *A Textbook of Electrical Technology (Vol. I)*, by B. L. Theraja and A. K. Theraja, S. Chand Publishing, New Delhi. 2. *Principles of Electronics*, by V. K. Mehta and Rohit Mehta, S. Chand Publishing, New Delhi. 3. *Basic Electrical Engineering*, by J. B. Gupta, S. K. Kataria & Sons, New Delhi. 4. *Modern Physics*, by R. Murugeshan and Kiruthiga Sivaprasath, S. Chand Publishing, New Delhi. 5. *Atomic and Nuclear Physics*, by Satya Prakash, R. D. Madan and K. P. Singh, S. Chand Publishing, New Delhi. 6. *Elements of Solid State Physics*, by J. P. Srivastava, Pragati Prakashan, Meerut. 7. *Solid State Physics*, by S. O. Pillai, New Age International Publishers, New Delhi. 8. *Solid State Physics*, by Puri and Babbar, S. Chand Publishing, New Delhi.

	9. *B.Sc. Practical Physics*, by C. L. Arora, S. Chand Publishing, New Delhi. 10. *Practical Physics*, by S. L. Gupta and V. Kumar, Pragati Prakashan, Meerut. 11. *Practical Physics*, by R. K. Shukla and Anchal Srivastava, New Age International Publishers, New Delhi. 12. *Modern Physics and Solid State Physics Practical Manual*, by H. S. Bhatia, Vishal Publishing Co., Jalandhar.

Physics EL Theory 1(a) – 129234	
Digital Electronics - I	
Credits: 02	**Workload (Hrs./Week): 02**
Course Objectives:	1. To develop understanding of number systems, binary arithmetic, and digital codes used in digital electronics. 2. To introduce the basic concepts of logic gates and their applications in digital circuits. 3. To explain Boolean algebra, De Morgan's theorems, and simplification of logic circuits. 4. To develop analytical skills for designing and analysing digital logic circuits using truth tables and Karnaugh maps. 5. To understand the working and applications of combinational logic circuits such as adders, subtractors, encoders, decoders, multiplexers, and demultiplexers. 6. To develop problem-solving skills in digital electronics through circuit analysis and design. 7. To provide practical knowledge of integrated circuits and digital electronic components used in modern electronic systems.
Course Outcomes:	By the end of the course, students will be able to: 1. Perform interconversion between decimal, binary, and hexadecimal number systems and apply binary arithmetic operations. 2. Explain the concepts of binary codes, complements, and their applications in digital systems. 3. Identify and analyse the operation of basic and universal logic gates. 4. Apply Boolean algebra and De Morgan's theorems for simplification of logic circuits. 5. Design and analyse logic circuits using truth tables, SOP method, and Karnaugh maps. 6. Explain the construction and operation of combinational logic circuits such as adders and subtractors. 7. Describe the working of encoders, decoders, multiplexers, and demultiplexers using truth tables and ICs. 8. Develop analytical and problem-solving skills in digital electronics and logic circuit design.

Unit	Contents	Work load Allotted	Weight-age of Marks Allotted	Incorporation of Pedagogies
I	**Number systems and codes**: Decimal, binary, and hexadecimal number systems and their interconversion; 1's and 2's complement; binary addition, subtraction, multiplication, and division; subtraction by 1's and 2's complement. Binary codes: 8421 BCD, Excess-3, and Gray code.	7 Hrs	8 Marks	• Lecture method • Numerical practice • Binary conversion exercises • ICT-based teaching • Problem-solving approach
II	**Logic gates**: Difference between analog and digital circuits; concept of logic gates; positive and negative logic; AND, OR, and NOT gates; NAND and NOR gates as universal gates; EX-OR and EX-NOR gates.	7 Hrs	8 Marks	• Demonstration method • Logic gate simulation • Interactive teaching • Circuit diagram practice • Conceptual explanation
III	**Boolean algebra**: Boolean laws; De Morgan's theorems; simplification of logic circuits using Boolean algebra; minterms and maxterms; conversion of a truth table into an equivalent logic circuit by Sum of Products (SOP) method and Karnaugh map (up to 4 variables); half adder, full adder, half subtractor, and full subtractor.	8 Hrs	8 Marks	• Analytical teaching • Truth table method • Karnaugh map practice • Problem-solving sessions • Collaborative learning
IV	**Combinational logic circuits**: Encoders—binary to BCD, decimal to BCD, IC 74147. Decoders—4-bit binary decoder, BCD to 7-segment decoder, IC 7447. Multiplexer (4×1) and demultiplexer (1×4): Definition, construction, operation, and truth tables.	8 Hrs	8 Marks	• Demonstration of ICs • Circuit design practice • Simulation-based teaching • Application-oriented teaching • Seminar/presentation method

References:	
References:	1. *Modern Digital Electronics* by R. P. Jain, Tata McGraw-Hill Publishing Co. Ltd., New Delhi. 2. *Digital Principles and Applications* by A. P. Malvino and D. P. Leach, Tata McGraw-Hill Publishing Co. Ltd., New Delhi. 3. *Digital Fundamentals* by Thomas L. Floyd, Pearson Education. 4. *Digital Integrated Electronics* by H. Taub and D. Schilling, McGraw-Hill Book Company, Delhi. 5. *Digital Electronics* by W. H. Gothmann, Prentice Hall of India Pvt. Ltd. 6. *Digital and Analog Techniques* by Navneet Kale and Gokhale, Kitab Mahal Prakashan. 7. *Experiments in Digital Principles* by Donald P. Leach, McGraw-Hill International Edition. 8. *Digital Electronics* by G. K. Kharate, Oxford University Press. 9. *Digital Techniques and Applications* by V. G. Yangalwar, Nirali Prakashan. 10. *Digital Electronics and Logic Design* by N. G. Palan, Technova Publications. 11. *Digital Electronics: Principles, Devices and Applications* by Anil K. Maini, Wiley India. 12. *Advanced Digital Electronics, Microprocessor and 8051 Microcontroller* by Dr. Y. B. Gandole, Dr. D. S. Dhote, Dr. S. P. Yawale, G.C. Publishers, Nagpur.

Model questions for theory external/ internal examination.	
One sentence/ Very short answer questions (1 Mark)	1. Define Gray code. 2. What is meant by 2’s complement? 3. State De Morgan’s theorem. 4. What is a universal gate? 5. Define multiplexer.
Short answer questions (3 Marks)	1. Explain the interconversion between binary and hexadecimal number systems. 2. Differentiate between analog and digital circuits. 3. Explain NAND gate as a universal gate. 4. Simplify a Boolean expression using Boolean algebra. 5. Explain the working of a half adder with truth table.
Long Answer Questions (6 Marks)	1. Explain binary arithmetic operations with suitable examples. 2. Describe various logic gates with their symbols and truth tables. 3. Explain De Morgan’s theorems and simplify logic expressions using Karnaugh maps. 4. Explain the construction and operation of a full adder and full subtractor with truth tables. 5. Describe the working of encoder, decoder, multiplexer, and demultiplexer with suitable diagrams and truth tables.

Physics EL Theory 1(b) – 129235	
Python Programming - I	
Credits: 02	**Workload (Hrs./Week): 02**
Course Objectives:	1. Introduce students to the fundamentals of Python programming and its relevance in physics. 2. Develop problem-solving skills using control structures and basic programming logic. 3. Familiarize students with data structures and modular programming concepts. 4. Enable students to handle basic file operations and use standard Python libraries. 5. Provide foundational knowledge of data visualization techniques for representing physical data.
Course Outcomes:	By the end of the course, students will be able to: 1. Understand and apply basic Python syntax, data types, and operators to solve simple problems. 2. Implement decision-making and looping constructs for logical problem-solving. 3. Utilize data structures (lists, tuples, dictionaries) and functions in program development. 4. Perform file handling operations and use standard Python modules effectively. 5. Create basic data visualizations using Matplotlib for analysis of scientific/physical data.

Unit	Contents	Work-load Allotted	Weight-age of Marks Allotted	Incorporation of Pedagogies
I	**Introduction to Python Programming:** • Setting up the environment: Jupyter Notebook, Anaconda, Spyder • Python interpreter, syntax, identifiers, keywords • Indentation and comments • Variables and data types: Integers, floats, strings, booleans, complex numbers • Basic operators: Arithmetic, relational, logical • Input/Output functions and string formatting	8 Hrs.	8 Marks	• Interactive lectures with live coding demonstrations • Hands-on practice in Jupyter Notebook, Anaconda, and Spyder • Laboratory exercises for syntax, variables, operators, and input/output • Problem-solving and activity-based learning using simple Python programs • Peer learning and group discussions
II	**Control Structures:** • Conditional statements: if, else, elif, nested if • Looping constructs: for loop, while loop; break, continue • Introduction to problem-solving using control structures	7 Hrs.	8 Marks	• Interactive lectures with flowcharts and program demonstrations • Hands-on coding practice for conditional statements and loops • Problem-solving exercises using real-life examples and logical tasks • Laboratory sessions for writing and debugging Python programs • Peer learning and group discussions for algorithm development
III	**Data Structures and Functions:** • Data structures: Lists (indexing, slicing); Tuples; Dictionaries • List comprehensions • Functions: Defining functions (def); Arguments and return values • Local and global variables	8 Hrs.	8 Marks	• Interactive lectures with examples of lists, tuples, dictionaries, and functions • Hands-on programming sessions for data manipulation and function creation • Demonstration of list comprehensions and variable scope using simple programs • Problem-solving activities based on data storage and processing • Laboratory exercises for writing modular Python programs.
IV	Modules, File Handling and Visualization: • Modules and libraries: Importing libraries (math, random) • File I/O: Reading and writing text files	7 Hrs.	8 Marks	• Interactive lectures with demonstrations of Python modules and file handling • Hands-on laboratory sessions for reading, writing, and managing text files

	• Introduction to data visualization: Basics of Matplotlib; plot(), scatter(); title, xlabel, ylabel, legend, grid			• Practical exercises using math and random libraries • Activity-based learning through data visualization using Matplotlib • Demonstrations of plotting graphs with labels, legends, and grids

References:	1. *Python for Physics*, David L. O'Brien (beginner-friendly introduction to Python for physics students). 2. *Python Programming for the Absolute Beginner*, Michael Dawson (a general Python programming book with examples applicable to physics). 3. *A Student's Guide to Python for Physical Modeling*, Jesse M. Kinder and Philip Nelson (focuses on using Python for basic physical modeling). 4. *Computational Physics: Problem Solving with Python*, Mark Newman (introductory concepts and examples focused on Python in physics). 5. Official Python Documentation: Python Docs 6. https://spoken-tutorial.org/tutorial-search/?search_foss=Python+3.4.3&search_language=English

Model questions for theory external/ internal examination.	
One sentence/ Very short answer questions (1 Mark)	1. What is the purpose of indentation in Python? 2. Define a Python list. 3. What is the use of the break statement in loops? 4. Name any two Python libraries used for mathematical operations and random number generation. 5. What is the function of xlabel() in Matplotlib?
Short answer questions (3 Marks)	1. Explain the role of Jupyter Notebook and Spyder in Python programming. 2. Differentiate between local and global variables with examples. 3. Write a Python program using if-else to check whether a number is even or odd. 4. Explain list indexing and slicing with suitable examples. 5. Describe the steps involved in reading and writing a text file in Python.
Long Answer Questions (6 Marks)	1. Explain Python data types and basic operators with suitable examples. 2. Discuss different looping constructs in Python with examples of for and while loops. 3. Explain functions in Python, including arguments, return values, and scope of variables. 4. Describe dictionaries and tuples in Python with suitable examples and applications. 5. Explain the basics of data visualization in Matplotlib with examples of plot() and scatter() graphs.

Physics EL Lab/ Practical 1(a) – 129236	
Experiments related to Digital Electronics - I	
Credits: 02	**Workload (Hrs./Week): 04**
Course Objectives:	1. To understand the basic operation and truth tables of fundamental logic gates. 2. To study the implementation of universal gates for constructing other logic gates. 3. To develop practical knowledge of digital logic circuits and Boolean operations. 4. To verify the functioning of combinational logic circuits such as adders, encoders, decoders, multiplexers, and demultiplexers. 5. To develop skills in designing, assembling, and testing digital electronic circuits. 6. To understand binary arithmetic operations using digital ICs. 7. To correlate theoretical concepts of digital electronics with practical applications. 8. To develop analytical, problem-solving, and circuit troubleshooting skills in digital electronics laboratory work.
Course Outcomes:	On successful completion of this course, the students will be able to 1. Identify and verify the operation of basic and universal logic gates using truth tables. 2. Construct and analyse digital logic circuits using NAND and NOR gates. 3. Perform binary arithmetic operations using digital electronic circuits and ICs. 4. Design and verify combinational logic circuits such as adders and subtractors. 5. Analyse and implement encoder, decoder, multiplexer, and demultiplexer circuits. 6. Apply Boolean logic and truth tables for digital circuit verification and analysis. 7. Develop practical skills in handling digital ICs, breadboards, and laboratory instruments. 8. Develop analytical, experimental, and troubleshooting skills in digital electronics.

List of Experiments: Perform at least eight (8) experiments from the given list.
1. To study the operation and verify the truth table of OR gate. 2. To study the operation and verify the truth table of AND gate. 3. To study the operation and verify the truth table of NOT gate (inverter). 4. To study the operation and verify the truth table of NOR gate. 5. To study the operation and verify the truth table of NAND gate. 6. To study the operation of NOR gate as NOT, OR, and AND gates. 7. To study the operation of NAND gate as NOT, OR, and AND gates. 8. To study the operation and verify the truth table of EX-OR gate. 9. To study the operation and verify the truth table of EX-NOR gate. 10. To assemble and study the operation of a half adder. 11. To carry out addition of 4-bit binary numbers using IC 7483 (4-bit full adder). 12. To study the operation of BCD to decimal decoder. 13. To study the operation of decimal priority encoder using IC 74147. 14. To study the operation of multiplexer (4×1). 15. To study the operation of demultiplexer (1×4).

References:	1. *Modern Digital Electronics* by R. P. Jain, Tata McGraw-Hill Publishing Co. Ltd., New Delhi. 2. *Digital Principles and Applications* by A. P. Malvino and D. P. Leach, Tata McGraw-Hill Publishing Co. Ltd., New Delhi. 3. *Digital Electronics* by G. K. Kharate, Oxford University Press. 4. *Digital Techniques and Applications* by V. G. Yangalwar, Nirali Prakashan. 5. *Digital Electronics and Logic Design* by N. G. Palan, Technova Publications. 6. *Experiments in Digital Principles* by Donald P. Leach, McGraw-Hill International Edition. 7. *Digital Electronics: Principles, Devices and Applications* by Anil K. Maini, Wiley India.

Physics EL Lab/ Practical 1(b) – 129237	
Experiments related to Python Programming - I	
Credits: 02	**Workload (Hrs./Week): 04**
Course Objectives:	1. Develop hands-on skills in writing, executing, and debugging Python programs. 2. Enable students to apply programming concepts to solve basic mathematical and physics problems. 3. Familiarize students with data handling, file operations, and use of scientific libraries. 4. Introduce students to graphical representation and visualization of scientific data.
Course Outcomes:	After successful completion of the course, students will be able to: 1. Write, execute, and debug Python programs using appropriate syntax and structures. 2. Apply programming techniques to solve numerical and physics-based problems. 3. Handle data using data structures, files, and basic scientific libraries. 4. Visualize and interpret data using plots and graphical tools.

List of Experiments: Perform at least eight (8) experiments from the given list.

1. Introduction to Python Environment: Writing and executing simple Python programs in Jupyter Notebook / Spyder.
   - i. Hello World Program
   - ii. Basic Arithmetic Operations
   - iii. Using Variables and Data Types
   - iv. User Input and Output
   - v. Area of a Circle
   - vi. Checking Even or Odd
   - vii. Simple For Loop
   - viii. Display Square of Numbers
   - ix. Basic Mathematical Functions
   - x. Simple Physics Example
2. Data Types and Operators: Programs using integers, floats, complex numbers, and strings; Perform arithmetic and logical operations
   - i. Program Using Different Data Types
   - ii. Type Checking Program
   - iii. Arithmetic with User Input
   - iv. Logical Operations
   - v. Relational (Comparison) Operations
   - vi. Combined Arithmetic and Logical Example
   - vii. String Operations
3. Input/Output Operations: Formatted output using f-strings and print(); User input-based calculations
   - i. Formatted Output using f-Strings
   - ii. Simple User Input and Output
   - iii. Area of a Circle
   - iv. Roots of a Quadratic Equation
   - v. Simple Interest Calculation
4. Conditional Statements: Programs using if, else, elif.
   - i. Check Even or Odd
   - ii. Largest of Three Numbers
   - iii. Grading System
   - iv. Check Positive, Negative, or Zero

v. Simple Physics Condition (Velocity Check)

5. Looping Constructs: for and while loops; Use of break and continue
    i. For Loop – Print First N Natural Numbers
    ii. While Loop – Factorial of a Number
    iii. Using break – Stop at a Specific Value
    iv. Using continue – Skip Even Numbers
    v. Physics Example – Sum Until Threshold (break)
6. Data Structures: Operations on lists (indexing, slicing); Programs using tuples and dictionaries
    i. List Indexing and Slicing
    ii. Basic List Operations
    iii. Tuple Operations
    iv. Dictionary Operations
    v. Physics Data Example using List & Dictionary
7. List Comprehension: Creating lists using list comprehensions
    i. Squares of Numbers
    ii. Even Numbers from a List
    iii. Convert Temperatures (°C to °F)
    iv. String Lengths
    v. Physics Example
8. Functions in Python: Defining and calling functions; Programs with arguments and return values
    i. Simple Function (No Arguments)
    ii. Function with Arguments
    iii. Function with Return Value
    iv. Function with Multiple Arguments and Return
    v. Physics Example
9. File Handling: Writing data to a text file; Reading and processing data from a file
    i. Writing Data to a Text File
    ii. Reading Data from a Text File
    iii. Reading File Line by Line
    iv. Writing and Reading Numerical Data
    v. Physics Data Processing from File
10. Basic Visualization using Matplotlib: Line plot, scatter plot; Plot customization: title, labels, legend, grid
    i. Simple Line Plot
    ii. Scatter Plot
    iii. Line Plot with Legend
    iv. Physics Example
    v. Combined Line and Scatter Plot
11. Mini Project
    - Analyzing experimental data
    - Simulating a simple physics system
16. Plotting and interpreting results

References:	1. *Python Programming* – Ashok Namdev Kamthane & Amit Ashok Kamthane, Publisher: McGraw Hill India *2.* *Programming and Problem Solving with Python* – Kamthane & Kamthane *3.* *Python Programming* – Jisu Elsa Jacob & Bharath Viswam S 4. *Basic and Advance Python Programming* – Agya Ram Verma 5. Official Python Documentation: Python Docs 6. *https://spoken-tutorial.org/tutorial-search/?search_foss=Python+3.4.3&search_language=English*

Physics MN Theory 5 – 129238	
Solid State Physics and Network Theorems	
Credits: 02	**Workload (Hrs./Week): 02**
Course Objectives:	1. To introduce students to the fundamental concepts of crystallography and crystal structures. 2. To develop understanding of unit cells, crystal systems, Bravais lattices, and Miller indices. 3. To explain X-ray diffraction methods and crystal defects in solid materials. 4. To familiarize students with electrical circuit analysis using Kirchhoff's laws and network theorems. 5. To develop analytical skills for solving multi-loop electrical circuits using Superposition, Thevenin's, and Norton's theorems. 6. To explain the concept of maximum power transfer and its practical applications in electrical circuits. 7. To introduce transient phenomena in LR, CR, and LCR circuits. 8. To develop understanding of alternating current circuits and phasor representation. 9. To explain concepts such as reactance, impedance, resonance, resonant frequency, and Q-factor in AC circuits. 10. To enhance problem-solving ability through numerical applications related to crystallography and electrical circuits.
Course Outcomes:	By the end of the course, students will be able to: 1. Explain the structure and properties of crystalline and amorphous solids. 2. Describe crystal systems, Bravais lattices, unit cells, and Miller indices used in crystallography. 3. Explain the principles of X-ray diffraction and identify different types of crystal defects. 4. Analyze electrical circuits using Kirchhoff's laws and mesh current analysis. 5. Apply Superposition, Thevenin's, Norton's, and Maximum Power Transfer theorems to solve electrical network problems. 6. Understand the behavior of transient currents in LR, CR, and LCR circuits. 7. Explain the concepts of alternating current, reactance, impedance, and phasor representation. 8. Analyze resonance conditions in LCR circuits and determine resonant frequency and Q-factor. 9. Solve numerical problems related to crystallography and electrical circuits. 10. Develop analytical, experimental, and problem-solving skills in solid-state physics and circuit analysis.

Unit	Contents	Workload Allotted	Weight-age of Marks Allotted	Incorporation of Pedagogies
I	**Crystallography I:** Amorphous and crystalline solids; Lattice; Unit cell; Primitive and non-primitive unit cells; Seven crystal systems; Bravais lattices; Properties of unit cell: coordination number, atoms per unit cell, atomic radius, packing fraction, and volume of a unit cell; Miller indices; Numerical.	8 Hrs	8 Marks	• Use crystal models and charts to explain lattice and unit cell concepts. • Demonstrate crystal systems and Bravais lattices using visual aids. • Conduct numerical sessions on packing fraction and coordination number. • Use diagrams for explaining Miller indices. • Encourage classroom discussions and conceptual questioning.
II	**Crystallography II:** Diffraction of X-rays by crystals; Bragg's law; Laue method; Powder diffraction method; Reciprocal lattice; Crystal defects: point defects, line defects, and plane defects; Numerical.	7 Hrs	8 Marks	• Explain X-ray diffraction using animations and diffraction patterns. • Demonstrate Bragg's law through numerical problems. • Use models and videos for Laue and powder diffraction methods. • Discuss crystal defects with suitable illustrations. • Conduct problem-solving sessions on diffraction and crystal parameters.
III	**Network Theorems and Circuit Analysis:** Kirchhoff's laws and analysis of multi-loop circuits; Superposition theorem (mesh current analysis); Thevenin's theorem; Norton's theorem; Maximum power transfer theorem and its applications; Numerical.	8 Hrs	8 Marks	• Use circuit diagrams to explain Kirchhoff's laws and network theorems. • Demonstrate mesh current analysis through solved examples. • Conduct numerical practice on Thevenin's and Norton's theorems. • Use real-life electrical circuits for application-based learning. • Encourage students to solve multi-loop circuit problems independently.
IV	**Transient and Alternating Current Circuits:** Rise and decay of current in LR circuits; Charging and discharging of capacitor in CR circuits; Transient response in LCR circuits; Alternating current and voltage; AC circuits containing resistor, inductor, and capacitor; LR, CR and LCR circuits; Phasor representation; Reactance and impedance; Resonance in LCR circuits; Resonant frequency and Q-factor; Numerical.	7 Hrs	8 Marks	• Explain transient response using circuit demonstrations and graphs. • Use phasor diagrams to teach AC circuit analysis. • Conduct numerical sessions on reactance, impedance, and resonance. • Demonstrate resonance in LCR circuits using experimental setup. • Use animations and simulations for AC and transient circuit behavior.

References:	1. *A Textbook of Crystallography* by P. K. Ghosh; S. Chand Publishing. 2. *Crystallography and Solid State Physics* by S. Raghunathan and M. Venkataraman; S. Chand Publishing. 3. *Solid State Physics: Structure and Properties of Materials* by M. A. Wahab; Narosa Publishing House. 4. *Solid State Physics* by N. W. Ashcroft and N. D. Mermin; TMH Publication. 5. *Solid State Physics* by J. S. Blakemore, 2nd Edition; Cambridge University Press. 6. *Solid State Physics* by C. L. Arora; S. Chand Publishing. 7. *Solid State Physics* by S. O. Pillai; New Age International Publishers. 8. *Solid State Physics* by A. J. Dekker, 8th Edition; Macmillan India Ltd. 9. *Elementary Solid State Physics* by M. Ali Omar; Pearson Education. 10. *Elements of Solid State Physics* by J. P. Srivastava; PHI Learning. 11. *Solid State Physics* by S. L. Kakani and C. Hemrajani; S. Chand Publishing. 12. Basic Electronics: Solid State, B. L. Theraja, S. Chand Publications. 13. Principles of Electronics, V. K. Mehta and Rohit Mehta, S. Chand Publications. 14. Heat, Thermodynamics and Statistical Physics, Brij Lal and N. Subrahmanyam, S. Chand Publications. 15. Refresher Course in B.Sc. Physics (Vol. II), C. L. Arora, S. Chand Publications.

Model questions for theory external/ internal examination.	
One sentence/ Very short answer questions (1 Mark)	1. Define a Bravais lattice. 2. What is meant by Miller indices? 3. State Kirchhoff's Current Law (KCL). 4. Define impedance in an AC circuit. 5. What is resonant frequency in an LCR circuit?
Short answer questions (3 Marks)	1. Differentiate between amorphous and crystalline solids. 2. Explain Bragg's law and its significance in crystal structure analysis. 3. State and explain Thevenin's theorem with suitable example. 4. Explain the charging and discharging process of a capacitor in a CR circuit. 5. Differentiate between reactance and impedance in AC circuits.
Long Answer Questions (6 Marks)	1. Explain the seven crystal systems and Bravais lattices with neat diagrams. 2. Describe X-ray diffraction methods and discuss different types of crystal defects. 3. State and prove Norton's theorem. Discuss its applications in electrical circuit analysis. 4. Explain transient response in LR, CR, and LCR circuits with suitable graphs. 5. Discuss resonance in LCR circuits and derive an expression for resonant frequency and Q-factor.

Physics MN Lab/ Practical 5 – 129239	
Experiments related to MN Th5	
Credits: 02	**Workload (Hrs./Week): 04**
Course Objectives:	1. To develop experimental skills and scientific understanding in solid-state physics and electrical network analysis through hands-on laboratory experiments. 2. To study crystal structures, crystal planes, and lattice parameters using crystal models and X-ray diffraction techniques. 3. To analyse X-ray diffraction data for the determination of crystallite size and understand the structural properties of crystalline and nanomaterials. 4. To verify and apply fundamental electrical network theorems such as Kirchhoff's laws, Thevenin's theorem, Norton's theorem, superposition theorem, and maximum power transfer theorem in practical circuits. 5. To understand the behaviour of AC and DC circuits involving resistance, inductance, and capacitance through experimental investigation of electrical networks. 6. To determine important electrical parameters such as inductance, capacitance, impedance, reactance, resonant frequency, phase difference, and Q-factor using standard laboratory methods. 7. To study resonance phenomena, transient response, charging–discharging processes, and filter characteristics in RC, LR, and LCR circuits. 8. To develop practical knowledge of electrical measuring instruments, signal sources, multimeters, CROs, and circuit components used in physics and electronics laboratories.
Course Outcomes:	On successful completion of this Practical course, the students would be able to: 1. Explain crystal structures, identify crystal planes, and analyse X-ray diffraction patterns for the determination of lattice parameters and crystallite size. 2. Apply and experimentally verify fundamental electrical network theorems including Kirchhoff's laws, Thevenin's theorem, Norton's theorem, superposition theorem, and maximum power transfer theorem. 3. Analyse the behaviour of AC and DC circuits involving resistance, capacitance, and inductance and determine electrical parameters such as impedance, reactance, capacitance, and inductance. 4. Investigate resonance phenomena in series and parallel LCR circuits and determine resonant frequency, phase difference, and Q-factor experimentally. 5. Study transient behaviour in RC, LR, and LCR circuits including charging–discharging processes, rise and decay of current, and determination of time constants. 6. Examine the characteristics of RC filters and interpret the frequency response and resonance curves of electrical circuits. 7. Use laboratory instruments such as multimeters, CROs, function generators, and electrical circuit components effectively and safely during experiments. 8. Record observations systematically, analyse experimental data, estimate errors, and present scientific results using graphs, tables, and proper calculations.

List of Experiments: Perform at least eight (8) experiments from the given list.
1. To study crystal models and identify crystal planes. 2. To determine lattice parameters using X-ray diffraction patterns. 3. To analyse X-ray diffraction data and estimate the crystallite size of nanomaterials. 4. To verify Thevenin's theorem. 5. To verify Norton's theorem. 6. To verify the maximum power transfer theorem. 7. To verify the superposition theorem. 8. To verify Kirchhoff's laws using electrical networks. 9. To measure inductance by the phasor diagram method. 10. To measure capacitance by the phasor diagram method. 11. To study resonance in a series LCR circuit and determine its Q-factor. 12. To study an RC circuit as a filter. 13. To determine the time constant of an RC circuit. 14. To determine high resistance by the leakage method. 15. To study the rise and decay of current in an LR circuit. 16. To study the charging and discharging of a capacitor in an RC circuit. 17. To determine impedance and reactance in AC circuits. 18. To study the phase difference between current and voltage in LCR circuits. 19. To verify the resonance condition in a parallel LCR circuit. 20. To plot the resonance curve for an LCR circuit. 21. To study the transient response of an LCR circuit. 22. To determine the resonant frequency of an LCR circuit.

References:	1. *B.Sc. Practical Physics*, by C. L. Arora, S. Chand Publishing, New Delhi. 2. *Practical Physics*, by S. L. Gupta and V. Kumar, Pragati Prakashan, Meerut. 3. *A Text Book of Practical Physics*, by Indu Prakash and Ramakrishna, Kitab Mahal, Allahabad. 4. *Advanced Practical Physics for Students*, by B. L. Flint and H. T. Worsnop (Indian Edition), Asia Publishing House, Mumbai. 5. *Basic Electrical Engineering*, by J. B. Gupta, S. K. Kataria & Sons, New Delhi. 6. *A Textbook of Electrical Technology (Vol. I)*, by B. L. Theraja and A. K. Theraja, S. Chand Publishing, New Delhi. 7. *Principles of Electronics*, by V. K. Mehta and Rohit Mehta, S. Chand Publishing, New Delhi. 8. *Solid State Physics*, by S. O. Pillai, New Age International Publishers, New Delhi. 9. *Elements of Solid State Physics*, by J. P. Srivastava, Pragati Prakashan, Meerut. 10. *Solid State Physics*, by Puri and Babbar, S. Chand Publishing, New Delhi. 11. *Introduction to Solids*, by Leonid V. Azaroff (Indian Edition), Tata McGraw-Hill Publishing Company, New Delhi. 12. *Basic Electronics and Linear Circuits*, by N. N. Bhargava, D. C. Kulshreshtha and S. C. Gupta, Tata McGraw-Hill Publishing Company, New Delhi.

Physics VSC-4 Lab/ Practical – 129240	
Maintenance and Repairing of Domestic Appliances	
Credits: 02	**Workload (Hrs./Week): 04**
Course Objectives:	1. To introduce the working principles of common domestic electrical appliances. 2. To develop basic skills in repairing, servicing, and maintenance of household appliances. 3. To understand electrical wiring, circuits, and safety precautions used in domestic appliances. 4. To develop troubleshooting and fault diagnosis skills for electrical appliances. 5. To enhance vocational and self-employment skills in appliance servicing and maintenance.
Course Outcomes:	After completing the course, the student will be able to: 1. Explain the construction and working of common domestic electrical appliances. 2. Identify electrical components and circuits used in household appliances. 3. Perform basic servicing, maintenance, and repair of domestic appliances. 4. Diagnose common faults and carry out troubleshooting safely. 5. Demonstrate practical skills useful for self-employment and technical service sectors.

Unit	Theoretical Background	Lab/ Practical/ Demonstrations/Activities
I	**Basics of Domestic Electrical Appliances** • Introduction to domestic electrical appliances • Basic electrical wiring and components • AC and DC power supply basics • Electrical safety precautions • Use of testing instruments: multi-meter, tester, continuity tester.	1. Identification of electrical components used in domestic appliances. 2. Testing of switches, fuse, and wiring continuity using multi-meter. 3. Cleaning and preventive maintenance of appliances. 4. Safety practices during appliance servicing.
II	**Household Appliances and Circuits-I** • Electric iron: construction, working, and thermostat circuit • Electric geyser: construction, working, and thermostat circuit • Water purifier: electrical circuits, pump and power supply system • Common faults • Troubleshooting methods • Replacement of faulty components • Testing after repair and servicing.	5. Study of electric iron and thermostat operation. 6. Repair and servicing of electric iron. 7. Study of electrical circuit used in water purifier. 8. Replacement of damaged electrical components.
III	**Household Appliances and Circuits-II** • AC/DC fan: construction, winding basics, regulator circuit • Mixer grinder: motor, switch, and speed control circuit • Common faults • Troubleshooting methods • Replacement of faulty components • Testing after repair and servicing	9. Study of AC/DC fan and regulator circuit. 10. Fault diagnosis and servicing of electric fan. 11. Replacement of damaged electrical components. 12. Study of mixer grinder motor and wiring. 13. Maintenance and troubleshooting of mixer grinder.
IV	**LED Lighting Systems and Fabrication** • Basic electronic components used in LED circuits • LED bulb and LED lamp construction • LED street lighting systems • Decorative and serial LED lighting systems • Driver circuits and power supplies for LEDs • Fabrication and assembly methods • Common faults in LED lighting systems • Testing of LEDs and driver circuits • Replacement of faulty components • Repairing techniques for decorative LED lighting • Preventive maintenance and safety practices	14. Identification of LED components and driver circuits. 15. Study of LED lamp construction and working. 16. Fabrication of simple LED lamp circuit. 17. Assembly of decorative LED lighting system. 18. Study of LED street light system. 19. Testing of LED driver circuits using multi-meter. 20. Fault diagnosis in LED lamp. 21. Repair and replacement of defective LEDs. 22. Repairing of decorative LED lighting circuits.

References:	1. *Electrical Engineering Laboratory Manual*, New Age International Publishers. 2. *Basic Electrical and Electronics Engineering Lab Manual*, S. Salivahanan, McGraw Hill Education. 3. *Practical Electrical Engineering Laboratory Manual*, Dhanpat Rai & Co. 4. *Electrical Wiring and Maintenance Lab Manual*, NIMI Publications. 5. *Domestic Appliance Servicing and Repair Manual*, DGT / NIMI Publications. 6. *Basic Electronics Practical Manual*, Oxford University Press. 7. *LED Lighting Systems Practical Handbook*, NIELIT Publications. 8. *Workshop Practice in Electrical Engineering*, Tata McGraw Hill Publishing.

Physics SEC-3 Lab/ Practical – 129241	
Fundamentals of Computer Applications in Physics Laboratory and Scilab Programming	
Credits: 02	**Workload (Hrs./Week): 04**
Course Objectives:	1. To introduce the fundamentals of computers, operating systems, hardware, software, networking, and their applications in Physics. 2. To develop skills in spreadsheet applications for scientific data handling, statistical analysis, graph plotting, and error analysis. 3. To provide foundational knowledge of Scilab programming including variables, operators, control structures, functions, and graphical visualization. 4. To train students in solving mathematical and physical problems using numerical methods, matrix operations, calculus, and differential equations in Scilab. 5. To familiarize students with simulation and modelling of physical systems using Xcos and computational tools relevant to Physics applications.
Course Outcomes:	Upon successful completion, students will be able to: 1. Demonstrate understanding of computer fundamentals, scientific software tools, and applications of computers in Physics laboratories and research. 2. Perform scientific data analysis using spreadsheets, including statistical calculations, graphical representation, and error estimation. 3. Write, execute, and debug Scilab programs using control statements, arrays, functions, and plotting tools for scientific computations. 4. Apply Scilab techniques to solve numerical problems involving calculus, matrices, linear algebra, and ordinary differential equations related to physical systems. 5. Develop and simulate basic physical models such as RC circuits, harmonic oscillators, and mass–spring systems using Xcos and computational methods.

Unit	Theoretical Background	Lab/ Practical/ Demonstrations/Activities

I	**Fundamentals of Computer Applications**
	
	1. Introduction to computers and operating systems
	2. Hardware and software concepts
	3. Application of computers in Physics
	4. Input-output devices and storage systems
	5. Computer networks and internet applications
	6. Introduction to scientific software tools.
		1. Internet Applications in Physics
		• Search scientific information using internet browsers.
		• Visit educational websites such as:
		  ○ NPTEL
		  ○ Virtual Labs
		  ○ NDLI
		  ○ PhET Simulations
		• Download Physics notes, articles, and graphs.
		• Learn safe and ethical use of internet resources.
		2. Scientific Document Preparation
		• Prepare Physics laboratory reports using word processor.
		• Insert tables, equations, images, and symbols.
		• Use formatting tools such as:
		  ○ font styles,
		  ○ paragraph alignment,
		  ○ page numbering,
		  ○ headers and footers.
		• Save reports in PDF format.
		3. Preparation of Scientific Presentations
		• Create PowerPoint presentations on Physics topics.
		• Insert graphs, images, animations, and equations.
		• Use slide transitions and presentation tools.
		• Deliver short presentations in class.
		4. Use of Online Scientific Tools
		• Use online calculators for scientific calculations.
		• Perform unit conversions using digital tools.
		• Use scientific notation and logarithmic calculations.

II	**Spreadsheet Applications and Data Handling:**
	
	1. Introduction to spreadsheets
	2. Data entry and formatting techniques
	3. Basic formulas and functions
	4. Statistical calculations: mean, median, standard deviation
		5. Data Entry and Table Preparation
		6. Basic Spreadsheet Calculations
		• Use formulas for:
		  ○ addition,
		  ○ subtraction,
		  ○ multiplication,
		  ○ division.
		• Calculate averages and percentages.

	5. MS Excel for scientific calculations 6. Graph plotting and chart preparation 7. Error analysis and significant figures	• Use spreadsheet functions such as: o SUM(), o AVERAGE(), o MAX(), o MIN(). **7**. Statistical Analysis of Experimental Data • Calculate: o mean, o median, o standard deviation, o percentage error. • Compare repeated experimental observations. • Analyse precision and accuracy of measurements. **8**. Graph Plotting and Chart Preparation • Plot graphs for experimental data such as: o distance vs time, o voltage vs current, o temperature vs resistance. • Label axes and choose appropriate scales. • Interpret slope and intercept of graphs. **9**. Preparation of Histograms and Pie Charts • Represent frequency distribution using histograms. • Compare datasets using pie charts and bar graphs. • Analyse variation in observations visually. **10**. Preparation of Scientific Data Sheets • Prepare formatted observation tables. • Create practical record sheets digitally. • Organize laboratory data systematically.
III	**Introduction to Scilab Programming and Applications:** 1. Introduction to Scilab: Installation, interface, 2. Data types, variables, constants, arrays. 3. Operators and built-in functions. 4. Script files and editor. 5. Control structures: if, else, for, while loops. 6. User-defined functions and modular coding.	**11.** Installing compatible version of Scilab. **12.** Write basic scripts for arithmetic and physics-based calculations. **13.** Use if-else to classify the type of motion based on initial velocity and height. **14.** Use a for loop to calculate displacement $s = ut + \frac{1}{2} at^2$ over a series of time intervals. **15.** Demonstrate use of a while loop to compute n! **16.** Plotting trigonometric functions and Polynomials.

	7. 2D & 3D plotting: functions, labels, legends, subplots. 8. Matrix creation and operations, Linear algebra, polynomials.	**17.** Plotting projectile motion, potential surfaces.
IV	**Calculus and Differential Equations using Scilab** 1. Numerical and symbolic differentiation and integration. 2. Solving ordinary differential equations (using ODE solver). 3. Modelling special differential equations (SHM, RC circuits). **Simulation using Xcos** **1.** Introduction to Xcos: Interface and block diagram modeling. **2.** Simulating physical systems: RC circuits, harmonic oscillator, mass-spring systems.	**18.** Differentiate a symbolic expression for displacement $s(t)=5t^3+2t^2+7$ to find velocity and acceleration functions. **19.** Compute work done $W \int_a^b F(x)\,dx$, where $F(x) = 3x^2 + 2x$ over [0, 5]. **20.** Solve First-Order ODE for RC and RL Circuit **21.** Solve Second-Order ODE for Simple Harmonic Oscillator (SHM) **22.** Modelling of Special Differential Equations of damped oscillators and electric circuits. **23.** Solve Schrödinger equation and plot wavefunctions. **24.** Model an RC or LCR circuit using Xcos. **25.** Creating Xcos models for real-time system behaviour analysis.

References:	1. *Computer Fundamentals* — P.K. Sinha & Priti Sinha, BPB Publications. 2. *Fundamentals of Computers* — V. Rajaraman, PHI Learning. 3. *Computer Fundamentals and Programming in C* — Reema Thareja, Oxford University Press India. 4. *Introduction to Computers* — Alexis Leon & Mathews Leon, Leon Tech World. 5. *Computer Applications in Physics* — Suresh Chandra, Narosa Publishing House. 6. *Data Analysis Using Microsoft Excel* — Cengage India Edition. 7. *Statistical Methods* — S.P. Gupta, Sultan Chand Publications. 8. *Practical Physics* — C.L. Arora, S. Chand Publications. (Useful for graph plotting, error analysis, and scientific data presentation.) 9. *Computing in Scilab,* Chetana Jain (Cambridge University Press) 10. *Learning Physics through Scilab Programming,* Bikash Kumar Naik (Notion Press) 11. *Computer Simulations in Quantum Physics,* Prof. O. S. K. S. Sastri (Notion Press) 12. *Scilab Official Site: https://www.scilab.org/* 13. *FOSSEE SciLab Textbook Companion: https://scilab.in/foss_textbook* 14. *https://sites.google.com/view/pankajnagpure/online-courses/physics-with-scilab/video-lectures-lecture-notes* 15. *https://spoken-tutorial.org/tutorial-search/?search_foss=Scilab&search_language=English*

Physics FP/CEP-3 Project – 129242	
Field Project / CE Services in Physics: Phase-III	
Credits: 02	**Workload (Hrs./Week): 04**
Course Objectives:	1. To provide hands-on experience in applying theoretical physics knowledge to real-world challenges through field-based projects or community engagement (CE) services. 2. To train students in identifying, analyzing, and solving practical problems encountered in physics-related fieldwork or community service activities. 3. To encourage students to integrate physics concepts with interdisciplinary knowledge, technology, and societal needs. 4. To develop students' abilities to document, present, and communicate their field-based or community engagement work effectively to diverse audiences. 5. To instill a sense of responsibility and service by involving students in projects that address community issues related to science and technology.
Course Outcomes:	1. Students will be able to apply physics principles and analytical techniques to investigate and solve real-world problems in field settings. 2. Students will demonstrate proficiency in using experimental tools, instruments, and data analysis methods relevant to their field project or CE service. 3. Students will be able to design, plan, and execute a field project or community service activity from inception to completion, including documentation and reporting. 4. Students will effectively communicate their project findings and outcomes through written reports, presentations, or community engagement events. 5. Students will demonstrate an understanding of the ethical, environmental, and societal impacts of their work, showing a commitment to responsible scientific practice and community well-being.
• **Guidelines/SOP for Selection and Implementation of Field Projects / CE Services**	
1. Project Selection and Planning	• **Faculty Guidance:** Students will be assigned a faculty mentor to guide their project, providing expertise and resources. • **Project Topic:** The project topic should be relevant to physics and align with the student's interests and the available resources. • **Literature Review:** Students are expected to conduct a thorough literature review to understand existing knowledge and identify research gaps. • **Data Collection and Analysis:** Projects often involve experiments, simulations, or data analysis from existing sources, depending on the topic. • **Project Timeline:** The total time allocation for the student to carry out field project is 60 hours.
2. Data Analysis and Interpretation	• **Statistical Methods:** Students will learn and apply appropriate statistical methods to analyze data. • **Interpretation of Results:** Data should be interpreted within the context of the project, highlighting significant findings and limitations.
3. Report Writing and Presentation	• **Report Format:** A structured report format is usually followed, including an abstract, introduction, methodology, results, discussion, and conclusion. • **Data Presentation:** Data should be presented clearly and accurately using tables, graphs, and figures. • **Oral Presentation:** Students will be required to present their findings to peers and faculty.

4. CE Services (Community Engagement)	• **Community Needs:** Projects may focus on addressing specific community needs or challenges relevant to physics. • **Collaboration:** Students can collaborate with local organizations to implement their projects. • **Impact Assessment:** The impact of the project on the community should be evaluated.
5. Evaluation and Assessment	• **Project Report:** The final report will be assessed based on its content, organization, and the quality of the research. **(20 Marks)** • **Oral Presentation:** The presentation will be evaluated on clarity, engagement, and the ability to answer questions. **(10 Marks)** • **Faculty Evaluation:** The faculty mentor will assess the student's performance throughout the project. **(20 Marks)** • **Total 50 Marks**
Examples of Field Projects/CE Services in Physics	• **Environmental Physics:** Studying the impact of pollution on local ecosystems or developing renewable energy solutions. • **Health Physics:** Investigating the effects of radiation on human health or developing medical imaging technologies. • **Education:** Designing physics experiments or teaching physics to younger students. • **Community Outreach:** Organizing science workshops or engaging in scientific literacy initiatives. • **Research Project:** Study related to the subject Physics that contribute to the advancement of knowledge and the well-being of life on Earth.

Note: The extended portion of the Field Project/CE Services in Physics from Phase-II may be carried forward as Field Project/CE Services in Physics: Phase-III in the fifth semester, subject to the approval of the assigned faculty mentor.
The objectives of the project shall be decided phase-wise and a project report must be submitted at the end of every semester.

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI
FACULTY: Science and Technology
Subject: PHYSICS
Teaching and Learning Scheme for the Degree of Bachelor of Science (B.Sc.)
Three Years / Four Years - (Six/Eight Semesters) Bachelor Degree Programme

THIRD YEAR: Level 5.5 - SEMESTER – VI (T & L Credit Scheme)

Mode of Teaching	Vertical No	The Vertical	Type of Course	Course Code	Course Name	Credits	Workload (Hrs/Week)	Vertical Workload (Hrs/Week)
Classroom Teaching/ Lab Work (Practical/ Outdoor/ Field/Online/Hybrid)	A	Major	Physics MJ Theory 11	129243	Nuclear and Particle Physics	2	2	**10**
			Physics MJ Theory 12	129244	Quantum Mechanics	2	2	
			Physics MJ Theory 13	129245	Solid State Physics II	2	2	
			Physics MJ Lab/Practical 6	129246	Experiments related to MJ Th11, Th12 and Th13	2	4	
		Elective 2(a) or 2(b)	Physics EL Theory 2(a)	129247	Digital Electronics - II	2	2	**6**
			Physics EL Theory 2(b)	129248	Python Programming - II	2	2	
			Physics EL Lab/Practical 2(a)	129249	Experiments related to Digital Electronics - II	2	4	
			Physics EL Lab/Practical 2(b)	129250	Experiments related to Python Programming - II	2	4	
	B	Minor	Physics MN Theory 6	129251	Quantum Mechanics and Solid State Physics	2	2	**6**
			Physics MN Lab/Practical 6	129252	Experiments related to MN Th6	2	4	
	C	Generic/ Open Elective	-	-	-	0	0	**0**
	D	VSC	Physics VSC-5 Lab/Practical	129253	Solar Energy Technology and Applications	2	4	**4**
		SEC				0	0	
	E	AEC				-	-	**0**
		IKS (Generic)				-	-	
		VEC				-	-	
	F	Internship/ Apprenticeship/ OJT	Physics Int/App/OJT	129254	Internship/ Apprenticeship/ On-the-Job Training (OJT) in the Physics domain	4	8	**8**
		FP/CES				0	0	
		CC				0	0	
TOTAL						**22**	**34**	**34**

Physics MJ Theory 11 – 129243	
Nuclear and Particle Physics	
Credits: 02	**Workload (Hrs./Week): 02**
Course Objectives:	1. To introduce students to the fundamental properties of atomic nuclei and the basic concepts of radioactivity. 2. To develop understanding of nuclear forces, nuclear stability, and radioactive decay processes. 3. To explain the concepts of binding energy, mass defect, packing fraction, and their significance in nuclear physics. 4. To familiarize students with nuclear models such as the liquid drop model and shell model for explaining nuclear structure. 5. To provide knowledge of nuclear reactions, nuclear fission, fusion processes, and applications of nuclear energy. 6. To introduce the principles, construction, and applications of radiation detectors and particle accelerators. 7. To develop understanding of neutron physics, nuclear reactors, and radioactive safety measures. 8. To familiarize students with fundamental interactions and the classification of elementary particles. 9. To introduce quantum numbers, conservation laws, quark model, and modern concepts in particle physics. 10. To develop scientific reasoning, analytical ability, and problem-solving skills through numerical applications in nuclear and particle physics.
Course Outcomes:	By the end of the course, students will be able to: 1. Explain various nuclear properties such as nuclear size, mass, binding energy, magnetic moment, and nuclear stability. 2. Describe the nature of nuclear forces, radioactive decay processes, and the basic concepts of alpha, beta, and gamma radiations. 3. Apply concepts of mass defect, binding energy, packing fraction, radioactive decay, and Q-value to solve numerical problems. 4. Discuss different nuclear models, including the liquid drop model and shell model, along with their applications and limitations. 5. Explain the principles of nuclear fission, fusion, chain reactions, nuclear reactors, and the role of nuclear energy in stellar processes. 6. Understand the working principles, construction, and applications of radiation detectors such as ionization chambers, proportional counters, Geiger–Müller counters, and semiconductor detectors. 7. Describe the construction, working, and limitations of particle accelerators such as linear accelerators and cyclotrons. 8. Classify elementary particles and explain their properties, interactions, quantum numbers, and conservation laws. 9. Understand the quark model, fundamental interactions, and the significance of the Gell-Mann–Nishijima relation in particle physics. 10. Develop analytical and problem-solving skills related to nuclear physics, radiation physics, and elementary particle physics.

Unit	Contents	Work-load Allotted	Weight-age of Marks Allotted	Incorporation of Pedagogies
I	**Nuclear Properties and Radioactivity** Classification of nuclei: isotopes, isotones, isobars, and mirror nuclei; Nuclear properties: size, charge, mass, radius, density, spin, and magnetic moment; Relation between nuclear radius and mass number; Atomic mass unit, mass defect, packing fraction, and binding energy; Binding energy per nucleon and nuclear stability; Deuteron and deuteron binding energy; Characteristics of nuclear forces; Alpha, beta, and gamma radiations; Alpha decay: Geiger–Nuttall law, potential barrier, and tunnel effect (qualitative); Basic idea of Gamow theory and neutrino hypothesis; Numerical.	7 Hrs	8 Marks	• Use lecture-cum-discussion method for nuclear properties and radioactivity. • Explain concepts using diagrams, charts, and animations. • Conduct numerical problem-solving sessions on binding energy and radioactive decay. • Use simulations to explain alpha decay and tunnel effect. • Encourage classroom interaction through conceptual questions.
II	**Nuclear Models and Nuclear Energy** Liquid drop model: features and limitations; Shell model and nuclear magic numbers; Semi-empirical mass formula (qualitative); Nuclear reactions and Q-value; Compound nucleus and reaction cross-section; Neutrons: properties, production, and detection; Nuclear fission and chain reaction; Nuclear reactors and breeder reactors (basic idea); Nuclear fusion and source of stellar energy; Comparison between nuclear fission and fusion; Radioactive hazards and safety measures; Numerical.	8 Hrs	8 Marks	• Explain nuclear models using comparative teaching methods. • Use videos and diagrams for fission, fusion, and nuclear reactors. • Conduct numerical practice on Q-value and nuclear reactions. • Organize group discussions on nuclear energy applications and hazards. • Use case studies related to nuclear reactors and stellar energy.
III	**Nuclear Detectors and Accelerators** Radiation detectors: Ionization chamber; Proportional counter; Geiger–Müller counter: construction, working, and	8 Hrs	8 Marks	• Use demonstration-based teaching for radiation detectors. • Explain detector construction and working with labeled diagrams. • Conduct laboratory experiments or virtual demonstrations. • Use animations to explain cyclotron

	applications; Semiconductor detector. Particle accelerators: Linear accelerator; Cyclotron: construction, working, and limitations; Numerical.			and linear accelerator. • Encourage student presentations on modern detectors and accelerators.
IV	**Elementary Particles** Fundamental interactions: gravitational, electromagnetic, strong, and weak; Classification of elementary particles: matter particles and force carriers, leptons, mesons, baryons, and antiparticles; Elementary particles: electron and positron, muon, neutrinos (electron, muon, and tau neutrinos), pi mesons and K mesons, proton and neutron, hyperons (basic idea only); Quantum numbers: charge, spin, baryon number, lepton number, isospin, and strangeness; Conservation laws: charge, baryon number, and lepton number; Gell-Mann–Nishijima relation (qualitative); Quark model and types of quarks.	7 Hrs	8 Marks	• Use particle classification charts and concept maps for teaching. • Explain fundamental interactions with simple examples. • Use visual aids and videos related to particle physics experiments. • Conduct discussions on conservation laws and quark model. • Encourage seminars and conceptual quizzes for active learning.

References:	8. *Introduction to Nuclear and Particle Physics* by V. K. Mittal, R. C. Verma, and S. C. Gupta; PHI Learning. 9. *Refresher Course in Physics for B.Sc. Classes, Vol. III* by C. L. Arora; S. Chand Publishing. 10. *Nuclear Physics* by D. C. Tayal; Himalaya Publishing House. 11. Concepts of Modern Physics by Arthur Beiser; McGraw Hill Education. 12. Introduction to Elementary Particles by David J. Griffiths; Wiley India. 13. *Nuclear Physics* by Irving Kaplan; Narosa Publishing House. 14. *Nuclear Physics* by R. Prasad; Pearson India. 15. *Nuclear and Particle Physics* by Satya Prakash; Pragati Prakashan. 16. *Nuclear and Particle Physics* by A. B. Gupta; Books & Allied Publishers. 17. *Nuclear Physics* by S. N. Ghoshal; S. Chand Publishing. 18. *Nuclear Radiation Detectors* by S. S. Nigam and Roy; S. Chand Publishing.

Model questions for theory external/ internal examination.	
One sentence/ Very short answer questions (1 Mark)	1. Define packing fraction. 2. State the relation between nuclear radius and mass number. 3. What are nuclear magic numbers? 4. Name any two radiation detectors used in nuclear physics. 5. What is meant by baryon number?
Short answer questions (3 Marks)	1. Differentiate between isotopes, isotones, and isobars with suitable examples. 2. Explain the characteristics of nuclear forces. 3. Discuss the working principle of the Geiger–Müller counter with a neat labelled diagram. 4. Explain the process of nuclear fission and chain reaction. 5. Describe the classification of elementary particles into leptons, mesons, and baryons.
Long Answer Questions (6 Marks)	1. Explain alpha decay on the basis of tunnelling effect and discuss the Geiger–Nuttall law. 2. Describe the liquid drop model of nucleus. Discuss its achievements and limitations. 3. Explain the construction and working of a cyclotron. Discuss its limitations. 4. Derive the expression for binding energy and explain the significance of binding energy per nucleon curve in nuclear stability. 5. Explain the quark model and discuss different quantum numbers and conservation laws associated with elementary particles.

Physics MJ Theory 12 – 129244	
Quantum Mechanics	
Credits: 02	**Workload (Hrs./Week): 02**
Course Objectives:	1. To develop understanding of the fundamental concepts and principles of quantum mechanics. 2. To explain the limitations of classical physics and the origin of quantum theory through experimental phenomena. 3. To introduce wave-particle duality, matter waves, uncertainty principle, and wave function concepts. 4. To develop analytical and mathematical skills in solving quantum mechanical problems. 5. To understand Schrödinger equations, operators, eigenvalues, and eigenfunctions in quantum systems. 6. To study quantum models such as particle in one-dimensional and three-dimensional boxes. 7. To explain quantum tunnelling, harmonic oscillator, and zero-point energy with physical applications. 8. To develop scientific reasoning, problem-solving ability, and conceptual understanding of microscopic systems.
Course Outcomes:	At the end of the course, students will be able to: 1. Explain the failure of classical physics and the experimental foundations of quantum mechanics. 2. Describe wave-particle duality, matter waves, photoelectric effect, and Compton effect. 3. Apply Heisenberg's uncertainty principle and interpret the physical significance of wave functions. 4. Solve problems related to de Broglie wavelength, uncertainty relations, and quantum mechanical systems. 5. Understand and apply Schrödinger time-dependent and time-independent equations. 6. Explain quantum mechanical operators, eigenvalues, and eigenfunctions. 7. Analyse the behaviour of particles in one-dimensional and three-dimensional potential boxes. 8. Describe quantum tunnelling, harmonic oscillator, and zero-point energy with their applications. 9. Develop analytical, mathematical, and problem-solving skills in quantum mechanics.

Unit	Contents	Work-load Allotted	Weight-age of Marks Allotted	Incorporation of Pedagogies
I	Failure of classical wave theory in explaining black body radiation; Planck's quantum hypothesis; Photoelectric effect: experimental observations and Einstein's photoelectric equation; Compton effect and its significance; Wave Particle duality; De Broglie hypothesis and matter waves; Davisson and Germer experiment; Concept of wave packet, Phase velocity and group velocity; Numerical	8 Hrs	8 Marks	• Lecture-cum-discussion method • Simulation-based teaching • Conceptual explanation with diagrams • Numerical problem-solving sessions • ICT-enabled teaching
II	Heisenberg uncertainty principle and its different forms; Thought experiments: gamma-ray microscope and single slit diffraction; Wave function and its physical significance; Conditions for acceptable wave function; Normalization and orthogonality of wave functions; Probability density and expectation value (basic idea); Numerical.	7 Hrs	8 Marks	• Lecture-cum-discussion method • Thought experiment method • Interactive teaching-learning • Mathematical derivation approach • Numerical practice sessions • ICT-enabled teaching
III	Schrödinger time-dependent and time-independent equations; Operators in quantum mechanics: momentum, kinetic energy and Hamiltonian operators; Eigenvalues and eigenfunctions; Particle in one-dimensional infinite potential box: Energy eigenvalues, Normalized eigenfunctions, Physical interpretation; Numerical.	8 Hrs	8 Marks	• Lecture-cum-discussion method • ICT-enabled teaching • Stepwise derivation method • Analytical teaching approach • Graphical visualization • Problem-solving pedagogy • Collaborative learning activities
IV	Particle in three-dimensional box: energy eigenvalues and degeneracy; Rectangular potential barrier and tunnelling effect; Linear harmonic oscillator and zero-point energy; Applications of quantum tunnelling (alpha decay); Numerical.	7 Hrs	8 Marks	• Lecture-cum-discussion method • ICT-enabled teaching • Visualization and animation method • Application-oriented teaching • Comparative teaching method • Numerical practice sessions • Seminar and presentation activities

References:	1. Quantum Mechanics: A Textbook for Undergraduates — Mahesh C. Jain, PHI Learning. 2. Quantum Mechanics — B. K. Agarwal and Hari Prakash, PHI Learning. 3. A Textbook of Quantum Mechanics — P. M. Mathews and K. Venkatesan, Tata McGraw-Hill. 4. Quantum Physics — H. C. Verma, Bharati Bhawan. 5. Fundamentals of Quantum Mechanics — Ajit Kumar, CRC Press India. 6. A Textbook on Modern Quantum Mechanics — A. C. Sharma, CRC Press. 7. Quantum Mechanics — Dr. M. Deben Singh, Rajesh Publications. 8. Quantum Mechanics — Satya Prakash and Swati Saluja, Sultan Chand & Sons. 9. Quantum Mechanics — Ajay Ghatak and S. Lokanathan, Trinity Press. 10. Quantum Mechanics – Arul Das, PHI 11. Concept of Modern Physics by Arthur Baiser, TMH 7th Edition

Model questions for theory external/ internal examination.	
One sentence/ Very short answer questions (1 Mark)	1. Define de Broglie wavelength. 2. State Heisenberg's uncertainty principle. 3. What is meant by wave function? 4. Define eigenvalue in quantum mechanics. 5. What is zero-point energy?
Short answer questions (3 Marks)	1. Explain the failure of classical wave theory in explaining black body radiation. 2. Describe the Davisson–Germer experiment and its significance. 3. Derive the relation between phase velocity and group velocity. 4. Explain the physical significance of a normalized wave function. 5. Discuss the concept of tunnelling effect with one application.
Long Answer Questions (6 Marks)	1. Derive Einstein's photoelectric equation and explain the characteristics of photoelectric effect. 2. Explain Heisenberg's uncertainty principle using gamma ray microscope thought experiment. 3. Derive Schrödinger time-independent equation and explain its physical significance. 4. Derive the energy eigenvalues and normalized eigenfunctions for a particle in a one-dimensional box. 5. Explain the linear harmonic oscillator and discuss the significance of zero-point energy.

Physics MJ Theory 13 – 129245	
Solid State Physics - II	
Credits: 02	**Workload (Hrs./Week): 02**
Course Objectives:	1. To introduce students to the electrical properties of solids and the behaviour of free electrons in materials. 2. To explain classical and quantum free electron theories and their applications in understanding electrical conductivity. 3. To develop understanding of concepts such as density of states, Fermi energy, and energy band structure. 4. To classify solids into metals, semiconductors, and insulators on the basis of band theory. 5. To introduce the fundamental concepts of superconductivity and superconducting materials. 6. To explain important phenomena such as Meissner effect, critical temperature, and critical magnetic field. 7. To familiarize students with BCS theory, Cooper pair formation, and applications of superconductors. 8. To introduce the basic concepts of nanotechnology and nanomaterials. 9. To explain the effect of nanoscale dimensions on optical, electrical, magnetic, and mechanical properties of materials. 10. To develop understanding of synthesis methods and medical as well as industrial applications of nanomaterials.
Course Outcomes:	At the end of the course, students will be able to: 1. Explain the electrical properties of solids using classical and quantum free electron theories. 2. Describe concepts such as mean free path, drift velocity, electrical conductivity, thermal conductivity, and Wiedemann–Franz law. 3. Understand the limitations of classical free electron theory and the significance of Sommerfeld's quantum theory. 4. Explain density of states, Fermi energy, Bloch theorem, and band structure of solids. 5. Classify materials as metals, semiconductors, and insulators on the basis of band theory. 6. Apply concepts of electrical properties and band theory to solve numerical problems. 7. Describe the phenomenon of superconductivity, Meissner effect, and properties of Type-I and Type-II superconductors. 8. Explain Cooper pair formation, BCS theory, and applications of superconducting materials. 9. Understand the properties, synthesis methods, and applications of nanomaterials and nanotechnology. 10. Analyse the effect of nanoscale dimensions on optical, electrical, magnetic, and mechanical properties of materials.

Unit	Contents	Work-load Allotted	Weight-age of Marks Allotted	Incorporation of Pedagogies
I	**Electrical Properties of Solids – I:** Classical free electron theory (Drude–Lorentz model): mean free path, drift velocity, Ohm's law, electrical conductivity, thermal conductivity, and Wiedemann–Franz law; Limitations of classical theory; Quantum free electron theory (Sommerfeld's model).	8 Hrs	8 Marks	• Use lecture-cum-discussion method for free electron theories. • Explain electrical conductivity using diagrams and derivations. • Conduct numerical sessions on drift velocity and conductivity. • Use comparative teaching for classical and quantum theories. • Encourage conceptual questioning and classroom interaction.
II	**Electrical Properties of Solids – II:** Density of states; Concept of Fermi energy; Band structure: electron in periodic potential, Bloch theorem, Kronig–Penney (K–P) model, and energy bands; Classification of solids (metals, insulators, and semiconductors) on the basis of band theory; Numerical.	7 Hrs	8 Marks	• Use energy band diagrams to explain band theory. • Demonstrate density of states and Fermi energy graphically. • Explain Bloch theorem and K–P model using visual aids. • Conduct numerical practice on band structure concepts. • Use semiconductor applications to relate theory with practice.
III	**Superconductivity:** Introduction; Critical temperature; Critical magnetic field; Meissner effect; Type-I and Type-II superconductors; Cooper pair formation; BCS theory; Applications: MRI and medical imaging, magnetic levitation (Maglev trains), SQUIDs, and superconducting magnets. .	7 Hrs	8 Marks	• Explain superconductivity using animations and demonstrations. • Use videos to illustrate Meissner effect and Maglev trains. • Discuss Type-I and Type-II superconductors comparatively. • Introduce BCS theory through conceptual explanations. • Conduct discussions on modern applications of superconductors.
IV	**Nanotechnology:** Introduction to nanomaterials; Effect of reduction of dimensions on optical, electrical, magnetic, and mechanical properties; Surface-to-volume ratio and quantum confinement effect; Classification based on dimensions: 0D, 1D, 2D, and 3D nanomaterials; Synthesis of nanomaterials: top-down and bottom-up approaches; Medical and industrial applications of nanomaterials.	8 Hrs	8 Marks	• Use multimedia presentations to introduce nanotechnology. • Explain quantum confinement effect using diagrams and animations. • Discuss top-down and bottom-up synthesis methods. • Use case studies for medical and industrial applications. • Encourage seminar presentations on recent nanotechnology developments.

References:	1. *Crystallography and Solid State Physics* by S. Raghunathan and M. Venkataraman; S. Chand Publishing. 2. *Solid State Physics: Structure and Properties of Materials* by M. A. Wahab; Narosa Publishing House. 3. *Introduction to Solid State Physics* by Charles Kittel, 8th Edition; Wiley Publication. 4. *Solid State Physics* by N. W. Ashcroft and N. D. Mermin; TMH Publication. 5. *Solid State Physics* by J. S. Blakemore, 2nd Edition; Cambridge University Press. 6. *Solid State Physics* by C. L. Arora; S. Chand Publishing. 7. *Solid State Physics* by S. O. Pillai; New Age International Publishers. 8. *Solid State Physics* by A. J. Dekker, 8th Edition; Macmillan India Ltd. 9. *Elementary Solid State Physics* by M. Ali Omar; Pearson Education. 10. *Elements of Solid State Physics* by J. P. Srivastava; Prentice Hall of India. 11. *Solid State Physics* by S. L. Kakani and C. Hemrajani; S. Chand Publishing. 12. *Solid State Physics* by P. K. Saxena, R. C. Gupta, and M. Saxena; Pragati Prakashan. 13. *Solid State Physics* by R. K. Puri and V. K. Babbar; S. Chand Publishing. 14. *Problems in Solid State Physics* by S. O. Pillai; New Age International (P) Ltd. 15. *Solid State Physics* by P. K. Palanisamy; Scitech Publications. 16. *Solid State Physics: Essentials and Beyond* by David Snoke; Pearson Publication. 17. *Electrical Properties of Materials* by Prabhat Choudhary; Cambridge University Press India. 18. *Superconductivity, Superfluids and Condensates* by James F. Annett; Oxford University Press. 19. *Nanotechnology: Principles and Practices* by Sulabha K. Kulkarni; Capital Publishing Company. 20. *Nano: The Essentials* by T. Pradeep; Tata McGraw-Hill Publishing Company Ltd. (2007). 21. *Introduction to Nanoscience and Nanotechnology* by K. K. Chattopadhyay and A. N. Banerjee; PHI Learning Pvt. Ltd. 22. *Nanotechnology* by Rakesh Rathi; S. Chand & Company, New Delhi. 23. *Nanotechnology: Principles and Practices* by Sulabha K. Kulkarni; Capital Publishing Company, New Delhi.

Model questions for theory external/ internal examination.	
One sentence/ Very short answer questions (1 Mark)	1. Define drift velocity. 2. State Wiedemann–Franz law. 3. What is Fermi energy? 4. Define Meissner effect. 5. What is meant by quantum confinement effect?
Short answer questions (3 Marks)	1. Explain the limitations of classical free electron theory. 2. Differentiate between metals, semiconductors, and insulators on the basis of band theory. 3. Explain the significance of density of states and Fermi energy in solids. 4. Distinguish between Type-I and Type-II superconductors. 5. Explain top-down and bottom-up approaches for synthesis of nanomaterials.
Long Answer Questions (6 Marks)	1. Explain Drude–Lorentz theory of electrical conduction in solids and discuss its limitations. 2. Discuss the Kronig–Penney model and explain the origin of energy bands in solids. 3. Explain superconductivity and discuss Meissner effect and BCS theory. 4. Describe the applications of superconductors in MRI, SQUIDs, and magnetic levitation systems. 5. Explain the effect of reduction in dimensions on the properties of nanomaterials and discuss their medical and industrial applications.

<table>
<tr><th colspan="2">Physics MJ Lab/ Practical 6 – 129246</th></tr>
<tr><th colspan="2">Experiments related to MJ Th11, Th12 and Th13</th></tr>
<tr><th>Credits: 02</th><th>Workload (Hrs./Week): 04</th></tr>
<tr><td>Course Objectives:</td><td>1. To develop experimental skills and scientific understanding in the areas of nuclear physics, quantum physics, and solid-state physics through hands-on laboratory experiments.
2. To study the fundamental principles of radioactivity, nuclear decay, radiation detection, and statistical nature of radioactive processes using Geiger–Müller counters and scintillation detectors.
3. To understand the operation and characteristics of radiation detection instruments and determine important parameters such as operating voltage, plateau region, dead time, half-life, and absorption coefficient.
4. To verify important concepts of quantum physics and modern physics through experiments related to black body radiation, photoelectric effect, Planck's constant, work function, and photocell characteristics.
5. To investigate the interaction of light and matter and analyse photoelectric and optical phenomena using photocells and related experimental setups.
6. To study the electrical, thermal, and magnetic properties of semiconductors and conducting materials through measurements of energy gap, Hall coefficient, conductivity, thermo-emf, dielectric constant, and resistance variation with temperature.
7. To understand the behaviour of semiconductors, thermistors, superconductors, and thermoelectric devices and their practical applications in modern electronic and solid-state devices.
8. To develop practical knowledge of experimental techniques such as four-probe method, reverse-bias method, Hall effect measurements, and temperature-dependent electrical studies.</td></tr>
<tr><td>Course Outcomes:</td><td>By the end of this course, students will be able to:
1. Demonstrate understanding of radioactive decay, nuclear statistics, and radiation detection techniques through experiments using Geiger–Müller counters and scintillation detectors.
2. Determine important nuclear parameters such as operating voltage, plateau region, resolving time, half-life, and absorption coefficient using standard nuclear physics experimental methods.
3. Verify and analyse fundamental concepts of quantum physics including black body radiation, photoelectric effect, Planck's constant, work function, and inverse square law.
4. Study and interpret the electrical characteristics of photocells and explain the interaction between radiation and matter experimentally.
5. Determine semiconductor properties such as energy gap, Hall coefficient, conductivity, dielectric constant, and resistance variation with temperature using appropriate experimental techniques.
6. Perform experiments related to thermistors, thermocouples, superconductors, and semiconductor devices and explain their physical behaviour and technological applications.
7. Apply experimental methods such as four-probe technique, reverse-bias method, Hall effect measurements, and temperature-dependent studies in solid-state physics.
8. Use laboratory instruments and radiation detection systems effectively and safely while conducting modern physics and solid-state physics experiments.</td></tr>
</table>

List of Experiments: Perform minimum eight (8) experiments from the given list. (at least 2 experiments related to each theory paper)
1. To study radioactive decay process using rolling of dice. 2. Determining the Operating Plateau and Operating Voltage for a Geiger–Müller counter. 3. Determination of resolving time (dead time) of a Geiger–Müller counter using the two-source method. 4. To study random nature of radioactivity using Geiger–Müller counter. 5. To determine half-life time of short half-life radioactive source using Geiger–Müller counter. 6. To determine Linear Absorption Coefficient of Al for Beta rays using Geiger–Müller counter. 7. To study gamma-ray detection with Scintillation counter. 8. Determination of Planck's constant using black body radiation spectrum. 9. Determination of Planck's constant using photoelectric effect. 10. Study of VI characteristics of Photocell. 11. Determination of work function of a metal using photoelectric effect. 12. To study inverse square law using photocell. 13. To determine the energy gap of a semiconductor using the four-probe method. 14. To determine the activation energy of a thermistor. 15. To determine the energy gap of a semiconductor using the reverse-bias method. 16. To study thermo-emf using a thermocouple. 17. To determine the Fermi energy of a given conductor by studying resistance variation with temperature. 18. To determine the dielectric constant of a given insulating material. 19. To determine the superconducting transition temperature using given temperature–resistance data. 20. To verify Ohm's law and study electrical conductivity of conducting materials. 21. To study the temperature dependence of resistance in a semiconductor.

References:	1. *B.Sc. Practical Physics*, by C. L. Arora, S. Chand Publishing, New Delhi. 2. *Practical Physics*, by S. L. Gupta and V. Kumar, Pragati Prakashan, Meerut. 3. *Advanced Practical Physics for Students*, by B. L. Flint and H. T. Worsnop (Indian Edition), Asia Publishing House, Mumbai. 4. *Modern Physics*, by R. Murugeshan and Kiruthiga Sivaprasath, S. Chand Publishing, New Delhi. 5. *Quantum Mechanics*, by Satya Prakash and Swati Saluja, Kedar Nath Ram Nath & Co., Meerut. 6. *Atomic and Nuclear Physics*, by Satya Prakash, R. D. Madan and K. P. Singh, S. Chand Publishing, New Delhi. 7. *Nuclear Physics*, by D. C. Tayal, Himalaya Publishing House, Mumbai. 8. *Concepts of Modern Physics*, by Arthur Beiser (Indian Edition), Tata McGraw-Hill, New Delhi. 9. *Solid State Physics*, by S. O. Pillai, New Age International Publishers, New Delhi. 10. *Solid State Physics*, by Puri and Babbar, S. Chand Publishing, New Delhi. 11. *Elements of Solid State Physics*, by J. P. Srivastava, Pragati Prakashan, Meerut. 12. *Electronic Devices and Circuits*, by Sanjeev Gupta, Dhanpat Rai Publications, New Delhi. 13. *Basic Electronics and Linear Circuits*, by N. N. Bhargava, D. C. Kulshreshtha and S. C. Gupta, Tata McGraw-Hill, New Delhi. 14. *Semiconductor Physics and Devices*, by S. O. Kasap (Indian Edition), Tata McGraw-Hill, New Delhi. 15. *A Textbook of Electrical Technology (Vol. I)*, by B. L. Theraja and A. K. Theraja, S. Chand Publishing, New Delhi.

<table>
<tr><th colspan="2">Physics EL Theory 2(a) – 129247</th></tr>
<tr><th colspan="2">Digital Electronics - II</th></tr>
<tr><th>Credits: 02</th><th>Workload (Hrs./Week): 02</th></tr>
<tr><td>Course Objectives:</td><td>1. To develop understanding of sequential logic circuits and various types of flip-flops.
2. To explain the working and applications of counters and shift registers in digital systems.
3. To introduce the principles and operation of analog-to-digital and digital-to-analog converters.
4. To develop analytical and problem-solving skills related to sequential and digital electronic circuits.
5. To understand the concept, classification, and hierarchy of semiconductor memories.
6. To study the construction and operation of RAM, ROM, PROM, EPROM, EEPROM, and flash memory devices.
8. To develop practical knowledge of digital electronic components and modern memory systems used in electronic devices.</td></tr>
<tr><td>Course Outcomes:</td><td>At the end of the course, students will be able to:
1. Explain the construction, working, and applications of various types of flip-flops.
2. Analyse sequential logic circuits using truth tables and logic diagrams.
3. Describe the operation of asynchronous and synchronous counters and shift registers.
4. Design and analyse up, down, up-down, and modified counters.
5. Explain the working principles of analog-to-digital and digital-to-analog converters.
6. Differentiate between various A/D and D/A conversion techniques.
7. Describe the classification, hierarchy, and operation of semiconductor memories.
8. Explain the functioning and applications of RAM, ROM, PROM, EPROM, EEPROM, and flash memory.
9. Develop analytical and problem-solving skills in sequential and digital electronic systems.</td></tr>
</table>

Unit	Contents	Work load Allotted	Weight-age of Marks Allotted	Incorporation of Pedagogies
I	Flip-flops: RS, clocked RS (CK-RS), D, JK, JK master-slave (JK-MS), and T flip-flops (logic diagram, truth table, construction, and working); concept of edge-triggered flip-flop; concept of preset and clear terminals.	7 Hrs	8 Marks	• Lecture method • Logic diagram demonstration • Truth table analysis • Simulation-based teaching • Interactive learning
II	Counters and shift registers: Asynchronous and synchronous counters; up counters, down counters, and up-down counters (up to 4-bits); modified asynchronous counters (Mod-7 and Mod-10); ring counter. Shift registers: SISO, SIPO, PISO, and PIPO.	7 Hrs	8 Marks	• Conceptual teaching • Counter design practice • Shift register demonstration • Problem-solving sessions • ICT-based teaching
III	A/D and D/A converters: Introduction. Digital-to-analog converters: Weighted resistor D/A converter and R-2R ladder D/A converter. Analog-to-digital converters: Parallel comparator A/D converter, successive approximation A/D converter, and voltage-to-frequency A/D converter.	8 Hrs	8 Marks	• Analytical teaching • Circuit demonstration method • Simulation of converters • Numerical practice • Application-oriented teaching
IV	Semiconductor memories: Concept of memory; classification of memories; primary and secondary memory; volatile and non-volatile memories; memory hierarchy. Semiconductor memories: RAM, ROM, PROM, EPROM, EEPROM, and flash memory.	8 Hrs	8 Marks	• Lecture-cum-discussion method • Memory hierarchy explanation • Diagram-based teaching • Comparative teaching method • Seminar/presentation activities

References:	1. *Modern Digital Electronics* by R. P. Jain, Tata McGraw-Hill Publishing Co. Ltd., New Delhi. 2. *Digital Principles and Applications* by A. P. Malvino and D. P. Leach, Tata McGraw-Hill Publishing Co. Ltd., New Delhi. 3. *Digital Fundamentals* by Thomas L. Floyd, Pearson Education. 4. *Digital Integrated Electronics* by H. Taub and D. Schilling, McGraw-Hill Book Company, Delhi. 5. *Digital Electronics* by W. H. Gothmann, Prentice Hall of India Pvt. Ltd. 6. *Digital and Analog Techniques* by Navneet Kale and Gokhale, Kitab Mahal Prakashan. 7. *Experiments in Digital Principles* by Donald P. Leach, McGraw-Hill International Edition. 8. *Digital Electronics* by G. K. Kharate, Oxford University Press. 9. *Digital Techniques and Applications* by V. G. Yangalwar, Nirali Prakashan. 10. *Digital Electronics and Logic Design* by N. G. Palan, Technova Publications. 11. *Digital Electronics: Principles, Devices and Applications* by Anil K. Maini, Wiley India. 12. *Advanced Digital Electronics, Microprocessor and 8051 Microcontroller* by Dr. Y. B. Gandole, Dr. D. S. Dhote, Dr. S. P. Yawale, G.C. Publishers, Nagpur.

Model questions for theory external/ internal examination.	
One sentence/ Very short answer questions (1 Mark)	1. Define flip-flop. 2. What is meant by edge triggering? 3. Define shift register. 4. What is EEPROM? 5. Define flash memory.
Short answer questions (3 Marks)	1. Differentiate between synchronous and asynchronous counters. 2. Explain the working of JK flip-flop with truth table. 3. Describe the operation of SISO shift register. 4. Explain the principle of R-2R ladder D/A converter. 5. Differentiate between RAM and ROM.
Long Answer Questions (6 Marks)	1. Explain the construction and working of JK master-slave flip-flop with logic diagram and truth table. 2. Describe the operation of up, down, and up-down counters with suitable diagrams. 3. Explain various types of shift registers and their applications. 4. Discuss the working of successive approximation A/D converter and compare it with parallel comparator A/D converter. 5. Explain the classification and hierarchy of semiconductor memories and discuss the working of RAM, ROM, EPROM, and EEPROM.

<table>
<tr><th colspan="2">Physics EL Theory 2(b) – 129248</th></tr>
<tr><th colspan="2">Python Programming - II</th></tr>
<tr><th>Credits: 02</th><th>Workload (Hrs./Week): 02</th></tr>
<tr><td>Course Objectives:</td><td>1. Introduce students to numerical computing using Python-based scientific libraries such as NumPy and SciPy.
2. Develop the ability to perform mathematical and linear algebra operations relevant to physical systems.
3. Equip students with numerical methods for solving integrals, equations, and differential equations.
4. Enable students to apply computational techniques to model and simulate physical phenomena.
5. Promote analytical thinking through visualization and interpretation of simulated physical data.</td></tr>
<tr><td>Course Outcomes:</td><td>After successful completion of this course, students will be able to:
1. Apply NumPy for efficient numerical computations and array-based operations.
2. Solve linear algebra problems (systems of equations, eigenvalues, eigenvectors) relevant to physics.
3. Implement numerical methods such as integration, root finding, and curve fitting using SciPy.
4. Solve ordinary differential equations numerically and interpret the results.
5. Develop and analyze computational models for basic physical systems such as motion, decay, and fields.</td></tr>
</table>

Unit	Contents	Work-load Allotted	Weight-age of Marks Allotted	Incorporation of Pedagogies
I	**Numerical Computing with NumPy** ▪ Introduction to NumPy arrays ▪ Array creation and generation techniques ▪ Array indexing, slicing, and reshaping ▪ Broadcasting concepts ▪ Mathematical operations on arrays: Array item selection and filtering	8 Hrs.	8 Marks	• Interactive Lectures: Explain NumPy concepts with real-time coding demonstrations. • Hands-on Practice: Conduct lab sessions for array creation, indexing, slicing, reshaping, and broadcasting. • Demonstration Method: Show mathematical operations and filtering using Jupyter Notebook/Google Colab.
II	**Linear Algebra using NumPy** ▪ Introduction to linear algebra in scientific computing ▪ Solving linear equations (Ax = B) ▪ Determinants and matrix operations ▪ Eigenvalues and eigenvectors using numpy.linalg ▪ Applications in simple physical systems	7 Hrs.	8 Marks	• Interactive Lectures: Introduce linear algebra concepts with numerical and physical examples. • Live Coding Demonstrations: Demonstrate matrix creation, operations, determinants, and solving linear equations using NumPy. • Hands-on Laboratory Sessions: Practice matrix manipulation, eigenvalue, and eigenvector computations using numpy.linalg.
III	**Scientific Computing with SciPy** ▪ Numerical integration: Trapezoidal rule; Simpson's rule ▪ Root finding methods: Bisection method; Newton-Raphson method ▪ Interpolation techniques ▪ Least squares fitting	8 Hrs.	8 Marks	• Interactive Lectures: Explain numerical methods and their importance in scientific computing. • Demonstration Method: Perform live coding demonstrations of integration, root finding, interpolation, and curve fitting using SciPy. • Hands-on Laboratory Sessions: Conduct practical exercises on numerical integration and equation solving.
IV	**Physics Simulations and Applications** ▪ Solving Ordinary Differential Equations (ODEs) using scipy.integrate ▪ Applications in Physics: Classical Mechanics: Projectile motion, simple	7 Hrs.	8 Marks	• Interactive Lectures: Introduce physical systems and numerical methods used in simulations. • Live Coding Demonstrations: Demonstrate solving ODEs and physics problems using scipy.integrate.

	pendulum; Electrodynamics: Electric field/potential using numerical methods; Thermodynamics: Radioactive decay modeling; Numerical solution of Schrödinger equation (basic case)			• Hands-on Laboratory Sessions: Conduct practical exercises on projectile motion, pendulum motion, radioactive decay, and electric field calculations. • Simulation-Based Learning: Use graphical visualization and animations to study system behavior and parameter variation.

References:	1. *Programming Using Python From Beginner to Pro*, DPS Publishing House 2. *Basic Python Programming For Beginners*, Dr. Marlapalli Krishna K. Varada Rajkumar Dr. Marlapalli Krishna & S. Jaya Prakash 3. *Python for Physics*, David L. O'Brien (beginner-friendly introduction to Python for physics students). 4. *Python Programming for the Absolute Beginner*, Michael Dawson (a general Python programming book with examples applicable to physics). 5. *A Student's Guide to Python for Physical Modeling*, Jesse M. Kinder and Philip Nelson (focuses on using Python for basic physical modeling). 6. *Computational Physics: Problem Solving with Python*, Mark Newman (introductory concepts and examples focused on Python in physics). 7. Official Python Documentation: Python Docs 8. https://spoken-tutorial.org/tutorial-search/?search_foss=Python+3.4.3&search_language=English

Model questions for theory external/ internal examination.	
One sentence/ Very short answer questions (1 Mark)	1. What is the main advantage of NumPy arrays over Python lists? 2. Define broadcasting in NumPy. 3. What is the purpose of numpy.linalg module? 4. State one application of the Newton-Raphson method. 5. Which SciPy module is commonly used for solving Ordinary Differential Equations (ODEs)?
Short answer questions (3 Marks)	1. Explain array indexing and slicing in NumPy with suitable examples. 2. Describe the method of solving linear equations using NumPy. 3. Explain the Trapezoidal rule for numerical integration. 4. What is interpolation? Explain any one interpolation technique. 5. Describe radioactive decay modeling using numerical methods.
Long Answer Questions (6 Marks)	1. Explain array creation, reshaping, and mathematical operations in NumPy with examples. 2. Discuss eigenvalues and eigenvectors using numpy.linalg and explain their applications in physics. 3. Explain the Newton-Raphson method for root finding with algorithm and example. 4. Describe least squares fitting and its applications in scientific data analysis. 5. Explain the numerical solution of Ordinary Differential Equations using

	scipy.integrate with applications to projectile motion or simple pendulum.

Physics EL Lab/ Practical 2(a) – 129249	
Experiments related to Digital Electronics - II	
Credits: 02	**Workload (Hrs./Week): 04**
Course Objectives:	1. To understand the construction and working of various flip-flops and sequential circuits. 2. To study the operation and applications of shift registers and counters. 3. To develop practical knowledge of sequential logic circuits using digital ICs. 4. To understand the working principles of A/D and D/A converters. 5. To study the operation and applications of semiconductor memory devices such as RAM. 6. To develop skills in assembling, testing, and analysing digital electronic circuits. 7. To correlate theoretical concepts of sequential logic and memory systems with practical implementation. 8. To develop analytical, experimental, and troubleshooting skills in digital electronics laboratory work.
Course Outcomes:	After successful completion of the laboratory course, students will be able to: 1. Analyse and verify the operation of different types of flip-flops and sequential logic circuits. 2. Construct and study the functioning of shift registers and binary counters using digital ICs. 3. Design and analyse up, down, up-down, and ring counters. 4. Understand and implement analog-to-digital and digital-to-analog conversion techniques. 5. Study and analyse the operation of semiconductor memory devices such as RAM. 6. Develop practical skills in assembling, testing, and troubleshooting digital electronic circuits. 7. Apply theoretical knowledge of sequential circuits and memory systems in practical applications. 8. Develop analytical, experimental, and problem-solving skills in digital electronics laboratory work.

List of Experiments: Perform at least eight (8) experiments from the given list.
1. To study the operation of RS flip-flop. 2. To study the operation of D flip-flop. 3. To study the operation of JK flip-flop. 4. To study the operation of JK master-slave (JK-MS) flip-flop. 5. To study the operation of SISO and PISO shift registers. 6. To study the operation of SIPO and PIPO shift registers. 7. To study the operation of binary ripple up-counter. 8. To study the operation of binary ripple down-counter. 9. To study the operation of up-down counter using IC 74193. 10. To study the operation of BCD counter using IC 7490A. 11. To study the operation of ring counter using IC 7495A. 12. To study the operation of RAM using IC 7489. 13. To study the operation of D/A converter based on R-2R ladder network. 14. To study the operation of successive approximation A/D converter using ADC 0804.

References:	1. *Modern Digital Electronics* by R. P. Jain, Tata McGraw-Hill Publishing Co. Ltd., New Delhi. 2. *Digital Principles and Applications* by A. P. Malvino and D. P. Leach, Tata McGraw-Hill Publishing Co. Ltd., New Delhi. 3. *Digital Electronics* by G. K. Kharate, Oxford University Press. 4. *Digital Techniques and Applications* by V. G. Yangalwar, Nirali Prakashan. 5. *Digital Electronics and Logic Design* by N. G. Palan, Technova Publications. 6. *Experiments in Digital Principles* by Donald P. Leach, McGraw-Hill International Edition. 7. *Digital Electronics: Principles, Devices and Applications* by Anil K. Maini, Wiley India. 8. *Digital Electronics* by S. Salivahanan and S. Arivazhagan, Vikas Publishing House. 9. *Digital Circuits and Design* by S. Salivahanan and S. Arivazhagan, Oxford University Press. 10. *Fundamentals of Digital Circuits* by Anand Kumar, PHI Learning. 11. *Digital Logic and Computer Design* by M. Morris Mano, Pearson Education. 12. *Digital Electronics* by B. R. Gupta, S. Chand Publications. 13. *A Textbook of Digital Electronics* by R. S. Sedha, S. Chand Publications. 14. *Digital Electronics and Microprocessors* by Rajaraman and Radhakrishnan, PHI Learning.

Physics EL Lab/ Practical 2(b) – 129250	
Experiments related to Python Programming - II	
Credits: 02	**Workload (Hrs./Week): 04**
Course Objectives:	1. Develop practical skills in using Python libraries such as NumPy and SciPy for numerical computations. 2. Enable students to implement linear algebra and numerical methods for solving scientific problems. 3. Provide hands-on experience in modeling and simulating physical systems computationally. 5. Enhance the ability to analyze, visualize, and interpret scientific data using computational tools.
Course Outcomes:	After successful completion of the course, students will be able to: 1. Perform numerical computations using NumPy for array operations and mathematical analysis. 2. Apply linear algebra and numerical methods to solve scientific and engineering problems. 3. Develop computational models and simulations for basic physical systems. 5. Visualize, analyze, and interpret numerical and simulation data effectively.

List of Experiments: Perform at least eight (8) experiments from the given list.

1. Introduction to NumPy Arrays
    - Create 1D and 2D arrays
    - Compare Python lists vs NumPy arrays
2. Array Creation and Manipulation
    - Using arange(), linspace(), zeros(), ones()
    - Reshaping arrays
3. Array Indexing and Slicing
    - Access elements in 1D and 2D arrays
    - Extract subarrays
4. Broadcasting and Vectorized Operations
    - Perform element-wise operations
    - Compare loop vs vectorized approach
5. Mathematical Operations on Arrays
    - Apply functions: sin, cos, exp, sqrt
    - Perform statistical operations
6. Solving Linear Equations (Ax = B)
    - Using numpy.linalg.solve()
7. Matrix Operations
    - Addition, multiplication, transpose
    - Determinant calculation
8. Eigenvalues and Eigenvectors
    - Using numpy.linalg.eig()
    - Interpretation of results
9. Numerical Integration
    - Trapezoidal rule
    - Simpson's rule
10. Root Finding Methods
    - Bisection method
    - Newton-Raphson method
11. Interpolation of Data
    - Linear and polynomial interpolation
12. Least Squares Curve Fitting
    - Fit straight line / curve to given data
13. Solving Ordinary Differential Equations (ODEs)
    - First-order ODE using scipy.integrate
    - Plot the solution
14. Projectile Motion Simulation
    - Plot trajectory using NumPy + Matplotlib
15. Simple Pendulum Simulation

- Numerical solution and visualization

16. Electric Field / Potential Calculation
    - Numerical computation using loops/arrays
17. Radioactive Decay Simulation
    - Exponential decay modeling and plotting
18. Introductory Schrödinger Equation (Basic Case)
    - Numerical solution for simple potential
19. Simulation-Based Mini Project (Any One):
    - Damped harmonic oscillator
    - Coupled oscillations
    - Data fitting from experimental dataset

15. Numerical solution of physics problems

References:	1. *Python Programming* – Ashok Namdev Kamthane & Amit Ashok Kamthane, Publisher: McGraw Hill India *2. Programming and Problem Solving with Python* – Kamthane & Kamthane *3. Python Programming* – Jisu Elsa Jacob & Bharath Viswam S 4. *Basic and Advance Python Programming* – Agya Ram Verma 5. Official Python Documentation: Python Docs 6. *https://spoken-tutorial.org/tutorial-search/?search_foss=Python+3.4.3&search_language=English*

Physics MN Theory 6 – 129251	
Quantum Mechanics and Solid State Physics	
Credits: 02	**Workload (Hrs./Week): 02**
Course Objectives:	1. To introduce students to the limitations of classical physics and the origin of quantum theory. 2. To explain important quantum phenomena such as black body radiation, photoelectric effect, and Compton effect. 3. To develop understanding of wave–particle duality and De Broglie hypothesis. 4. To familiarize students with matter waves, wave packets, phase velocity, and group velocity. 5. To explain Heisenberg uncertainty principle and its significance in quantum mechanics. 6. To introduce the concept of wave function, probability density, normalization, and expectation values. 7. To develop understanding of magnetic properties of materials and the origin of magnetism. 8. To explain magnetic parameters, classification of magnetic materials, and Langevin's theories of magnetism. 9. To introduce the basic concepts of nanotechnology and nanomaterials. 10. To explain the synthesis methods, properties, and medical as well as industrial applications of nanomaterials.
Course Outcomes:	By the end of the course, students will be able to: 1. Explain the failure of classical physics in describing black body radiation and other quantum phenomena. 2. Describe the principles of photoelectric effect, Compton effect, and wave–particle duality. 3. Explain De Broglie hypothesis, matter waves, wave packets, phase velocity, and group velocity. 4. Understand and apply Heisenberg uncertainty principle in different physical situations. 5. Explain the concept of wave function, normalization, orthogonality, probability density, and expectation values. 6. Solve numerical problems related to quantum concepts and uncertainty relations. 7. Describe the origin of magnetic moment and explain magnetic properties of materials. 8. Classify magnetic materials and explain Langevin's theories of diamagnetism and paramagnetism. 9. Understand the concepts of nanotechnology, quantum confinement effect, and nanoscale properties. 10. Explain the synthesis methods and applications of nanomaterials in medical and industrial fields.

Unit	Contents	Workload	Weight-	Incorporation of Pedagogies

		Allotted	age of Marks Allotted	
I	Failure of classical wave theory in explaining black body radiation; Planck's quantum hypothesis; Photoelectric effect: experimental observations and Einstein's photoelectric equation; Compton effect and its significance; Wave–particle duality; De Broglie hypothesis and matter waves; Davisson–Germer experiment; Concept of wave packet, phase velocity, and group velocity; Numerical.	8 Hrs	8 Marks	• Use animations and demonstrations to explain black body radiation and photoelectric effect. • Explain wave–particle duality using real-life examples and experiments. • Demonstrate De Broglie wavelength and Compton effect through derivations and numerical. • Use videos/simulations for Davisson–Germer experiment. • Conduct numerical problem-solving sessions on quantum concepts.
II	Heisenberg uncertainty principle and its different forms; Thought experiments: gamma-ray microscope and single-slit diffraction; Wave function and its physical significance; Conditions for acceptable wave function; Normalization and orthogonality of wave functions; Probability density and expectation value (basic idea); Numerical.	7 Hrs	8 Marks	• Explain uncertainty principle using conceptual discussions and thought experiments. • Use diagrams to illustrate gamma-ray microscope and single-slit diffraction. • Introduce wave function concepts through graphical representation. • Conduct numerical sessions on probability density and uncertainty relations. • Encourage conceptual questioning and classroom interaction. •
III	Origin of magnetic moment; Magnetic field strength (H), magnetic induction (B), and magnetization (M); Magnetic permeability (μ) and magnetic susceptibility (χ); Relation between B, H, and M; Classification of magnetic materials: diamagnetic materials, paramagnetic materials, and ferromagnetic materials; Langevin's theory of diamagnetism; Langevin's theory of paramagnetism; Curie law and Curie constant.	8 Hrs	8 Marks	• Use lecture-cum-discussion method for magnetic concepts. • Explain magnetic parameters using diagrams and examples. • Demonstrate classification of magnetic materials through charts. • Teach Langevin's theories with conceptual derivations. • Conduct numerical exercises on Curie law and magnetic susceptibility.

IV	Introduction to nanomaterials; Effect of reduction of dimensions on optical, electrical, magnetic, and mechanical properties; Surface-to-volume ratio and quantum confinement effect; Classification based on dimensions: 0D, 1D, 2D, and 3D nanomaterials; Synthesis of nanomaterials: top-down and bottom-up approaches; Medical and industrial applications of nanomaterials.	7 Hrs	8 Marks	• Use multimedia presentations to introduce nanotechnology. • Explain quantum confinement effect using diagrams and animations. • Discuss top-down and bottom-up synthesis methods. • Use case studies for medical and industrial applications. • Encourage seminar presentations on recent nanotechnology developments.

References:	1. *Quantum Mechanics: A Textbook for Undergraduates* by Mahesh C. Jain; PHI Learning. 2. *Quantum Mechanics* by B. K. Agarwal and Hari Prakash; PHI Learning. 3. *A Textbook of Quantum Mechanics* by P. M. Mathews and K. Venkatesan; Tata McGraw-Hill Publishing Company. 4. *Quantum Physics* by H. C. Verma; Bharati Bhawan Publishers. 5. *Fundamentals of Quantum Mechanics* by Ajit Kumar; CRC Press India. 6. *A Textbook on Modern Quantum Mechanics* by A. C. Sharma; CRC Press. 7. *Quantum Mechanics* by M. Deben Singh; Rajesh Publications. 8. *Quantum Mechanics* by Satya Prakash and Swati Saluja; Sultan Chand & Sons. 9. *Quantum Mechanics* by Ajay Ghatak and S. Lokanathan; Trinity Press. 10. *Quantum Mechanics* by Aruldhas; PHI Learning. 11. *Concepts of Modern Physics* by Arthur Beiser, 7th Edition; Tata McGraw-Hill Publishing Company. 12. *A Textbook of Crystallography* by P. K. Ghosh; S. Chand Publishing. 13. *Crystallography and Solid State Physics* by S. Raghunathan and M. Venkataraman; S. Chand Publishing. 14. *Solid State Physics: Structure and Properties of Materials* by M. A. Wahab; Narosa Publishing House. 15. *Introduction to Solid State Physics* by Charles Kittel, 8th Edition; Wiley Publication. 16. *Solid State Physics* by N. W. Ashcroft and N. D. Mermin; TMH Publication. 17. *Solid State Physics* by J. S. Blakemore, 2nd Edition; Cambridge University Press. 18. *Solid State Physics* by C. L. Arora; S. Chand Publishing. 19. *Solid State Physics* by S. O. Pillai; New Age International Publishers. 20. *Introduction to Nanoscience and Nanotechnology* by K. K. Chattopadhyay and A. N. Banerjee; PHI Learning Pvt. Ltd. 21. *Nanotechnology* by Rakesh Rathi; S. Chand & Company, New Delhi. 22. *Nanotechnology: Principles and Practices* by Sulabha K. Kulkarni; Capital Publishing Company, New Delhi.

Model questions for theory external/ internal examination.	
One sentence/ Very short answer questions (1 Mark)	1. State Planck's quantum hypothesis. 2. Define De Broglie wavelength. 3. What is meant by wave function? 4. Define magnetic susceptibility. 5. What is quantum confinement effect?
Short answer questions (3 Marks)	1. Explain the significance of Einstein's photoelectric equation. 2. Describe the Davisson–Germer experiment and its importance. 3. Explain Heisenberg uncertainty principle with suitable example. 4. Differentiate between diamagnetic and paramagnetic materials. 5. Explain top-down and bottom-up approaches for synthesis of nanomaterials.
Long Answer Questions (6 Marks)	1. Explain black body radiation and discuss Planck's quantum theory. 2. Derive Einstein's photoelectric equation and explain the experimental observations of photoelectric effect. 3. Explain the physical significance of wave function and discuss normalization and orthogonality conditions. 4. Discuss Langevin's theories of diamagnetism and paramagnetism. 5. Explain the effect of reduction in dimensions on the properties of nanomaterials and discuss their medical and industrial applications.

<table>
<tr><th colspan="2">Physics MN Lab/ Practical 6 – 129252</th></tr>
<tr><th colspan="2">Experiments related to MN Th6</th></tr>
<tr><th>Credits: 02</th><th>Workload (Hrs./Week): 04</th></tr>
<tr><td>Course Objectives:</td><td>1. To develop experimental skills and scientific understanding in modern physics, magnetism, and nanoscience through hands-on laboratory investigations.
2. To study fundamental concepts of thermal radiation, quantum physics, and photoelectric effect through the determination of physical constants such as Stefan’s constant and Planck’s constant.
3. To investigate the characteristics and applications of photocells and verify fundamental laws related to light intensity and photoelectric phenomena.
4. To understand the principles, operation, and magnetic behaviour of transformers, magnetic materials, and magnetic field measuring devices.
5. To study magnetic properties of materials by determining magnetic susceptibility, Curie temperature, hysteresis characteristics, and magnetic field distribution using standard experimental techniques.
6. To identify and classify dia-, para-, and ferromagnetic materials based on their magnetic behaviour and response to external magnetic fields.
7. To gain practical knowledge of magnetic field measurement using Hall probes, magnetometers, and related laboratory instruments.
8. To introduce synthesis techniques for nanomaterials through chemical reduction, sol–gel, and electrochemical deposition methods.</td></tr>
<tr><td>Course Outcomes:</td><td>On successful completion of this Practical course, the students would be able to:
1. Determine important physical constants such as Stefan’s constant and Planck’s constant using experimental methods based on thermal radiation and photoelectric effect.
2. Study and analyse the V–I characteristics of photocells and verify the inverse square law and work function of metals experimentally.
3. Explain the operation and characteristics of transformers and investigate magnetic hysteresis and B–H curves of ferromagnetic materials.
4. Measure magnetic fields using Hall probes, magnetometers, and related instruments, and interpret magnetic field behaviour experimentally.
5. Determine magnetic susceptibility of solids and liquids using Gouy’s balance and Quincke’s methods, respectively.
6. Determine the Curie temperature and classify dia-, para-, and ferromagnetic materials based on their magnetic properties.
7. Understand and perform basic synthesis techniques for nanomaterials using chemical reduction, sol–gel, and electrochemical deposition methods.
8. Record observations systematically, analyse experimental data, estimate uncertainties, and present scientific results using graphs, tables, and calculations.</td></tr>
</table>

List of Experiments: Perform at least eight (8) experiments from the given list.
1. To determine Stefan's constant. 2. To determine Planck's constant using the black body radiation spectrum. 3. To determine Planck's constant using the photoelectric effect. 4. To study the V–I characteristics of a photocell. 5. To determine the work function of a metal using the photoelectric effect. 6. To study the inverse square law using a photocell. 7. To study the characteristics and operation of a transformer. 8. To study hysteresis loss in a transformer core and plot the B–H curve. 9. To study the magnetic field using a bar magnet and compass box. 10. To determine the Earth's magnetic field using a magnetometer. 11. To determine the magnetic susceptibility of a magnetic material using Gouy's balance method. 12. To determine the magnetic susceptibility of a liquid using Quincke's method. 13. To determine the Curie temperature of a ferromagnetic material. 14. To plot the B–H curve (hysteresis loop) for a ferromagnetic material. 15. To identify dia-, para-, and ferromagnetic materials. 16. To study the chemical reduction method for the synthesis of nanoparticles. 17. To study the sol–gel method for the synthesis of nanoparticles. 18. To study the electrochemical deposition method for the synthesis of copper nanoparticles.

References:	1. *B.Sc. Practical Physics*, by C. L. Arora, S. Chand Publishing, New Delhi. 2. *Practical Physics*, by S. L. Gupta and V. Kumar, Pragati Prakashan, Meerut. 3. *A Text Book of Practical Physics*, by Indu Prakash and Ramakrishna, Kitab Mahal, Allahabad. 4. *Advanced Practical Physics for Students*, by B. L. Flint and H. T. Worsnop (Indian Edition), Asia Publishing House, Mumbai. 5. *Modern Physics*, by R. Murugeshan and Kiruthiga Sivaprasath, S. Chand Publishing, New Delhi. 6. *Concepts of Modern Physics*, by Arthur Beiser (Indian Edition), Tata McGraw-Hill Publishing Company, New Delhi. 7. *Atomic and Nuclear Physics*, by Satya Prakash, R. D. Madan and K. P. Singh, S. Chand Publishing, New Delhi. 8. *Solid State Physics*, by S. O. Pillai, New Age International Publishers, New Delhi. 9. *Elements of Solid State Physics*, by J. P. Srivastava, Pragati Prakashan, Meerut. 10. *Concepts of Solid State Physics*, by J. N. Mandal, Pragati Prakashan, Meerut. 11. *Physics of Materials: Essential Concepts of Solid-State Physics*, by Prathap Haridoss, Wiley India Pvt. Ltd., New Delhi. 12. *Principles of Electronics*, by V. K. Mehta and Rohit Mehta, S. Chand Publishing, New Delhi. 13. *A Textbook of Electrical Technology (Vol. I)*, by B. L. Theraja and A. K. Theraja, S. Chand Publishing, New Delhi. 14. *Practical Physics*, by P. R. Sasi Kumar, PHI Learning Pvt. Ltd., New Delhi.

Physics VSC-5 Lab/ Practical – 129253	
Solar Energy Technology and Applications	
Credits: 02	**Workload (Hrs./Week): 04**
Course Objectives:	1. To introduce the fundamentals of renewable energy sources with emphasis on solar energy and photovoltaic technology. 2. To develop understanding of solar PV system components, their functions, and system design. 3. To explain the working principles of on-grid, off-grid, and hybrid solar power systems. 4. To train students in installation procedures, safety practices, troubleshooting, and maintenance of solar PV systems. 5. To develop practical and vocational skills for performance monitoring and applications of solar energy systems in various sectors.
Course Outcomes:	After completing the course, the student will be able to: 1. Explain the basic concepts of solar radiation, photovoltaic effect, and solar energy conversion. 2. Identify and describe various components used in solar PV systems and their functions. 3. Differentiate between on-grid, off-grid, and hybrid solar systems with their applications. 4. Perform installation, testing, troubleshooting, and maintenance of solar PV systems following safety procedures. 5. Analyze the performance and energy output of solar PV systems for domestic, agricultural, and industrial applications.

Unit	Theoretical Background	Lab/ Practical/ Demonstrations/Activities
I	**Fundamentals of Solar Energy:** • Introduction to renewable and non-conventional energy sources • Need and importance of solar energy • Solar radiation and solar energy potential • Basic principle of photovoltaic effect • Types of solar cells and solar panels • Construction and working of solar PV module • Efficiency and rating of solar panels	1. Study of solar radiation measurement methods. 2. Identification and study of components of solar PV system. 3. Measurement of output voltage and current of solar panel. 4. Study of I-V characteristics of solar panel.
II	**Components of Solar PV System** • Solar PV modules and arrays • Battery and battery bank • Solar charge controller • Inverter and types of inverters • Mounting structures and wiring • DC and AC electrical protections • Earthing and lightning protection • Measuring instruments used in solar systems	5. Study of effect of tilt angle on output power of solar panel. 6. Study of solar battery charging system. 7. Study of solar charge controller. 8. Study of inverter and its operation. 9. Installation of small solar lighting system.
III	**On-Grid and Off-Grid Solar Systems:** • Introduction to on-grid solar systems • Components and working of on-grid systems • Net metering concept • Advantages and limitations of on-grid systems • Introduction to off-grid solar systems • Components and working of off-grid systems • Hybrid solar systems • Applications of solar PV systems in domestic, agricultural, and industrial sectors	10. Study of on-grid solar PV system. 11. Study of off-grid solar PV system. 12. Wiring and connection of solar PV modules.
IV	**Installation, Troubleshooting and Maintenance** • Site selection and shadow analysis • Installation procedure of solar PV systems • Panel mounting techniques • Electrical connections and safety precautions • Common faults in solar systems • Troubleshooting techniques • Preventive and corrective maintenance • Cleaning and washing of solar panels • Performance monitoring and energy output analysis	13. Testing and fault identification in solar systems. 14. Maintenance and servicing of solar panels. 15. Cleaning and washing techniques for solar panels. 16. Energy output analysis of solar PV system.

References:	1. Non-Conventional Energy Sources, by G. D. Rai, Khanna Publishers, New Delhi. 2. Renewable Energy Sources and Applications, by B. K. Hodge, Wiley India Pvt. Ltd., New Delhi. 3. Solar Energy Utilization, by G. D. Rai, Khanna Publishers, New Delhi. 4. Renewable Energy, by S. Rao and B. B. Parulekar, Khanna Publishers, New Delhi. 5. Basics of Solar Energy, by N. K. Bansal, Manfred Kleemann and Michael Meliss, Tata McGraw-Hill Publishing, New Delhi. 6. A Textbook of Energy Technology, by S. P. Sukhatme, Tata McGraw-Hill Publishing, New Delhi. 7. Practical Physics, by C. L. Arora, S. Chand Publishing, New Delhi. 8. Laboratory Manual for Solar Energy Experiments, by V. V. N. Kishore, TERI Press, New Delhi. 9. Installation and Maintenance of Solar Energy Systems, by Anil K. Maini, Khanna Publishers, New Delhi. 10. Handbook for Solar PV Technicians, by National Institute of Solar Energy (NISE), Ministry of New and Renewable Energy, Government of India.

<table>
<tr><th colspan="2">Physics Int/App/OJT – 129254</th></tr>
<tr><th colspan="2">Internship/ Apprenticeship/ On-the-Job Training (OJT) in the Physics domain</th></tr>
<tr><th colspan="2">Credits: 04 Workload (Hrs./Week): 08</th></tr>
<tr><td>Course Objectives:</td><td>1. To provide students with practical exposure to professional work environments related to physics, scientific research, technology and industry.
2. To develop technical and analytical skills through hands-on training in laboratories, industries, educational institutions, research organizations, or technology centers.
3. To enable students to apply theoretical concepts of physics in solving real-world scientific and technological problems.
4. To enhance students' professional competencies such as teamwork, communication, ethics, problem-solving and workplace discipline.
5. To familiarize students with modern instruments, experimental techniques, software tools and industrial practices used in physics-related fields.</td></tr>
<tr><td>Course Outcomes:</td><td>1. Students will be able to apply principles of physics and scientific methods in professional and industrial settings.
2. Students will demonstrate proficiency in handling instruments, laboratory equipment, computational tools, and data analysis techniques relevant to the internship/OJT domain.
3. Students will acquire practical problem-solving skills and workplace experience through participation in real-time projects or technical assignments.
4. Students will be able to prepare technical reports, maintain work records and effectively present their internship outcomes.
5. Students will demonstrate professional ethics, teamwork, safety awareness and responsibility in scientific and industrial environments.</td></tr>
<tr><td colspan="2">• Guidelines / SOP for Selection and Implementation of Internship / Apprenticeship / OJT</td></tr>
<tr><td>1. Selection and Planning of Internship/OJT</td><td>• Faculty Mentor: Each student shall be assigned a faculty mentor for guidance, monitoring and evaluation throughout the internship/OJT period.
• Host Organization: Internship/OJT may be carried out in industries, research laboratories, hospitals, educational institutions, government organizations, science centres, startups, renewable energy sectors, electronics servicing units or other physics-related organizations.
• Selection of Training Area: The training area should be relevant to physics and aligned with students' interests, career goals and available facilities.
• Approval Process: Students must obtain prior approval from the department before joining the internship/apprenticeship/OJT program.
• Duration: The total duration of internship/apprenticeship/OJT shall be equivalent to 120 hours.</td></tr>
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2. Training Activities and Learning Process	• Students shall actively participate in assigned practical tasks, technical activities, experiments, servicing, maintenance, simulations or data analysis work. • Students should observe workplace practices, safety procedures and professional ethics followed in the organization. • Training may involve activities such as instrumentation handling, calibration, electronics servicing, scientific data collection, software-based analysis, renewable energy systems, quality testing, or educational outreach. • Students shall maintain a daily logbook/record of activities certified by the supervisor of the host organization.
3. Documentation and Report Writing	• Students shall prepare a detailed internship/OJT report containing: ✓ Introduction of organization ✓ Objectives of training ✓ Description of activities performed ✓ Instruments/software/tools used ✓ Observations and results ✓ Skills acquired ✓ Challenges faced and solutions ✓ Conclusion and learning outcomes • Data, diagrams, photographs, graphs, and tables should be included wherever necessary. • The report should be duly certified by the organization supervisor and faculty mentor.
4. Presentation and Viva-Voce	• Students shall deliver an oral presentation or demonstration of their internship/OJT experience before faculty members and peers. • The presentation should include technical work carried out, outcomes achieved and practical knowledge gained. • Students should be able to answer questions related to their training and applications of physics concepts.
5. Evaluation and Assessment	• **Internship/OJT Report:** The final report will be assessed based on its content and organization. **(20 Marks)** • **Oral Presentation/Viva-Voce:** The presentation will be evaluated on clarity, engagement and the ability to answer questions. **(10 Marks)** • **Evaluation by Faculty Mentor/Supervisor:** The faculty mentor/ supervisor will assess the student's performance throughout Internship/OJT. **(20 Marks)** • **Total 50 Marks**
Examples of Areas for Internship / Apprenticeship / OJT in Physics	• Electronics Repairing and Maintenance • Solar Energy Systems and Renewable Energy • Scientific Instrumentation and Calibration • LED Lighting Systems and Electrical Appliances • Computer Hardware and Embedded Systems • Software and IT Industry • Industrial Automation and Sensors • Medical Physics and Diagnostic Equipment • Environmental Monitoring and Pollution Analysis • Physics Laboratory Assistance and Technical Support • Science Communication and Outreach Activities

	• Science Centre, Museum, and Innovation Hub Activities • Research Training in Universities or Laboratories • Data Analysis and Computational Physics Applications • Astronomy and Space Science Activities • Teaching Assistance and Physics Demonstration Activities • Research and Development in Universities and Laboratories • Non-Destructive Testing and Material Analysis • IoT-Based Scientific Applications and Arduino Projects • Any other Start – ups/ industries related to subject physics